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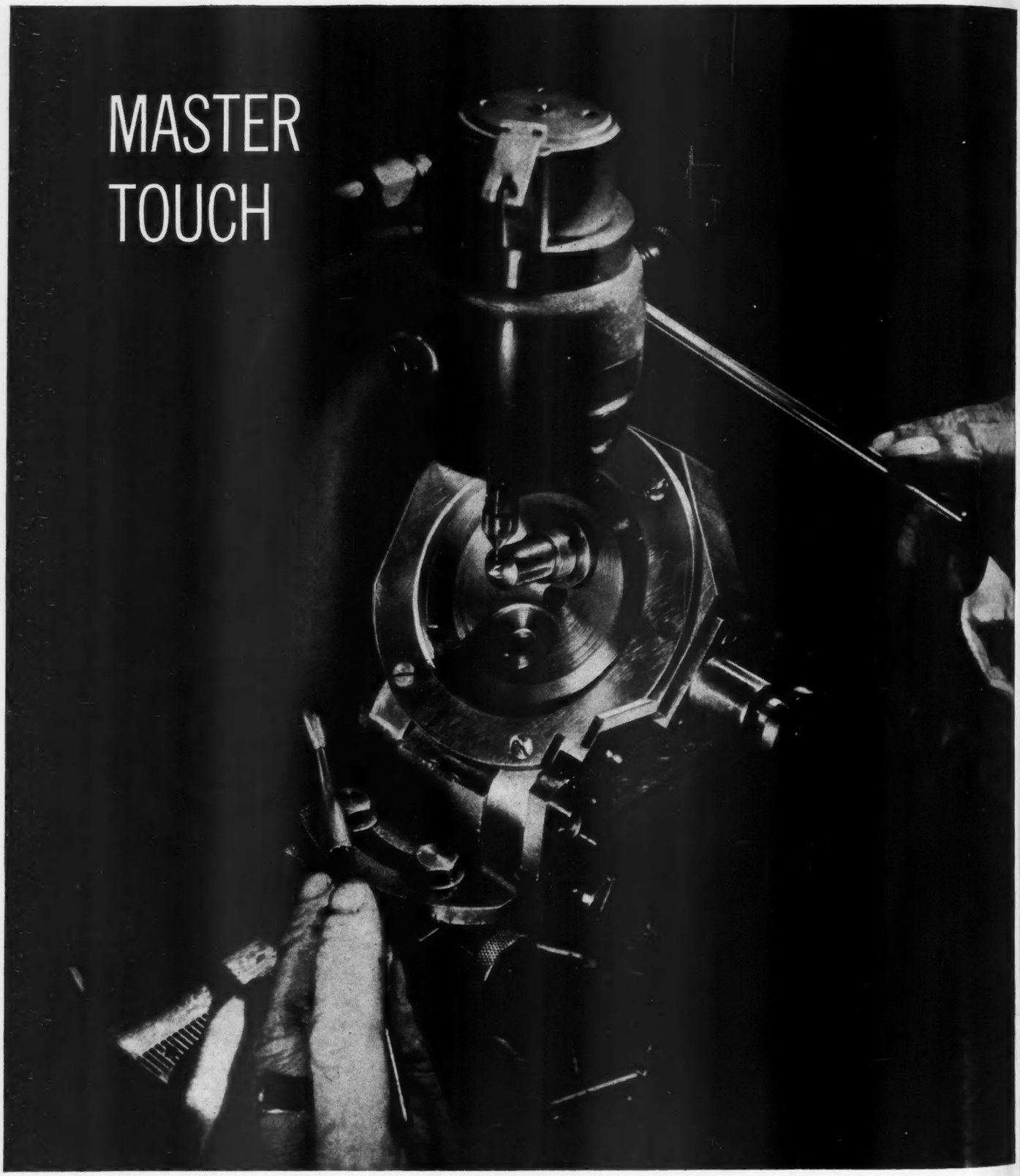

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AP 189

11 August 1961

Vol. 192 No. 4973

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone : Temple Bar 3663

Contents

162 Design

Liquid Oxygen Saves Space and Weight

Humidity Conditioning System, Structural Test on the Avro, Roller Filter for Use in Ducts

All Metal Shock Absorber, Research Work on Large Tanker, Underwater TV for Suez Canal, Miniature Pneumatic Actuator

170 Construction

Building a Textile Mill at Khartoum
By M. S. Forinton

The Abutment Block for Kariba's Southern Flank

173 New Plant and Equipment

Blast Furnace Drill, Solenoid Valve, Plastics Gold Blocking Machine, Rubber Sealed Bearings, Drum Rock, Vent Valve

Scrap Metal Baling Press, TV Document Transmitter, Moulding Machine, Small Diesel Starting Aid, Sound Level Indicator, Automatic Vertical Welder

Electronic Timer, Gear Analyzer, Dust Meter, Magnetometer, Dial Assembly, Low Tension Cell

178 Metals and Materials

Improved Forms of Industrial Graphite
By F. K. Earp, A. R. Ford and R. K. Hurden

180 Production

Printed Circuits Made Without Drawings
By W. Gosling

189 Research

Research Report:
Brittle Fracture in Welded Steel
By B. Cotterell

Cements to Resist Chemical Attack, Computer Based on Molecular Circuitry, Studies of Electrostatic Mineral Separation

161 Impact

169 Human Element

177 Companies

185 Marketing

Special Articles

166 Machines that Sort Signals from Noise

172 To File or Not to File Correspondence
By H. H. Goom

168 Automobile Review
Providing the Current in Future Cars

176 Atomic Review
Call for Cooperation

186 Product Profile
GPO Stamp Selling Machine

192 At Home
Waste Disposal

165 Plain Words
By Capricorn

165 Letters to the Editor
Two-Element Fluid Couplings
G. Monaghan

165 Events in Advance

182 Publications
On the Shelf
By Frank H. Smith

Books Reviewed:

An Anthology of Houses

The Attack on World Poverty

The Road to Modern Surgery

Thermoelectricity: including Proceedings of Conference sponsored by Naval Research Laboratory Sept. 1958
Thermoelectric Materials and Devices

Trade Publications and New Books

Cover Picture

A swivel axle for a motor car is being forged from a hot billet which has been heated in a gas furnace. The photograph was taken in a Midlands motor car factory.

Subscription Rates: Editorial page 192 Index to Advertisements: Overleaf Engineering Appointments Section: Faces Editorial page 176

Advertisers in 'Engineering' this week

	PAGE
Allen, Edgar, & Co., Ltd.	49
Associated Electrical Industries, Ltd.	
Heavy Plant Division.	45
Motor & Control Gear Division.	60
Transformer Division.	41
Auchterlonie, C., & Co., Ltd.	4
Barns, W., & Son (Holloway) Ltd.	31
Birwelco Ltd.	18
Blakeborough, J. & Sons, Ltd. *Wrapper*	VII
Booth, Jas. Aluminium Ltd.	62
Booth, Joseph, & Bros.	53
Bostock & Bramley, Ltd.	58
British Ermeto Corp., Ltd.	7
British Steam Specialties, Ltd.	36
British Twin Disc, Ltd.	10
Butterfield, W. P. (Engineers) Ltd.	9
C.A.V. Ltd. *Wrapper*	II
Carron Co.	9
Caston Barber Ltd.	31
Clyde Crane & Booth, Ltd.	53
Clyde Crane & Engineering Co.	53
Colt Ventilation, Ltd.	23
Conveyor & Elevator Co. (1936) Ltd.	10
Daimler-Benz AG. *Wrapper*	VI
Dawson & Downie, Ltd.	15
Drummond-Asquith, Ltd.	48
E.N.V. Eng'g. Co., Ltd.	27
Edwards, F. J. Ltd.	50
Empire Rubber Co.	54
English Steel Forge & Eng'g Corpn., Ltd.	20
Eyre Smelting Co., Ltd.	53
Fairfield Shipbuilding & Eng'g. Co., Ltd.	40
Falk, Stadelmann & Co., Ltd.	59
Fearnehough, W., Ltd.	54
Film Cooling Towers (1925) Ltd.	16
Firth, Thos., & John Brown, Ltd.	43
Ford Motor Co., Ltd.	42
General Descaling Co., Ltd.	56
Glover, Wm., J. & Co., Ltd.	24
Goodyear Tyre & Rubber Co. (G.B.) Ltd.	38
Grafton Cranes, Ltd.	26
Guest Keen & Nettlefolds (Midlands) Ltd.	61
Hingley, N., & Sons (Netherton) Ltd.	5
Holroyd, John, & Co., Ltd.	32
Hood, R., Haggie & Son, Ltd.	57
Imperial Chemical Industries Ltd. (Heat Treatment Division). *Wrapper*	V
Ionic Plating Co., Ltd.	34
Jones & Lloyd, Ltd.	54
Joy-Sullivan, Ltd.	33
Keelavite Hydraulics, Ltd.	21
Kent, G., Ltd.	42
King, G. W., Ltd.	55
Lafarge Aluminous Cement Co., Ltd.	28
Lake & Elliot, Founders & Engineers Ltd.	22
Leigh, W. & J., Ltd. *Wrapper*	III
Levy, B., & Co. (Patterns) Ltd.	10
Manchester Furnaces, Ltd.	10
Matthew Hall & Co., Ltd.	19
Metropolitan Construction Co., Ltd.	36
Midland Silicones, Ltd.	30
Monk, A., & Co., Ltd.	37
Morganite Carbon, Ltd.	63
Murex Welding Processes, Ltd.	12
Newbury Diesel Co., Ltd.	36
Parks Forge, Ltd.	36
Parsons, C. A., & Co., Ltd.	17
Paterson Eng'g. Co., Ltd. *Wrapper*	III
Positive Lock Washer Co., Ltd.	15
Priest Furnaces, Ltd.	26
Prior Stokers, Ltd.	44
Ratcliffe, F. S. (Rochdale) Ltd.	13
Rawlplug Co., Ltd.	35
Regent Oil Co., Ltd.	39
Renold Chains, Ltd. *Wrapper*	VIII
Reynolds Tube Co., Ltd.	57
Richardsons Westgarth (Hartlepool) Ltd.	11
Robertson, W. H. A., & Co., Ltd.	52
Robson, G., & Co. (Conveyors) Ltd.	26
Rotax, Ltd. *Wrapper*	IV
Sankey Green Wire Weaving Co., Ltd.	26
Saunders Valve Co., Ltd.	4
Scriven Machine Tools, Ltd.	26
Self-Changing Gears, Ltd.	44
Simmonds Aerocessories, Ltd.	47
Simon, Richard, & Sons, Ltd.	6
Skinningrove Iron Co., Ltd.	58
Smith, J. (Keighley) Ltd.	8
Smiths Industrial Instruments, Ltd.	25
Stein, J. G., & Co., Ltd.	10
Sturtevant Engineering Co., Ltd.	51
Sumo Pumps, Ltd.	13
Tangyes, Ltd.	38
Tecalemit, (Eng'g) Ltd.	14
Terry, H., & Sons, Ltd.	22
Thornycroft, J. I., & Co., Ltd.	5
Timber Development Association Ltd.	46
Wailes Dove Bitumastic, Ltd.	64
Wellman Bibby Co., Ltd.	50
Wellman Smith Owen Eng'g. Corpn., Ltd.	36
Wells, A. C., & Co., Ltd.	54
West, A., & Partners Ltd.	15
White, R., & Sons (Engineers) Ltd.	2
Widnes Foundry & Eng'g Co. Ltd.	20
Wiley, J., & Sons, Ltd.	4
Wiseman, A., & Co., Ltd.	1

'Engineering' Appointments Section inside Editorial Section

A.I.C.	1
Australian Scientific Office	1
Central Electricity Generating Bord	2
Imperial Chemical Industries Ltd.	1
Loughborough College	1
Mansell Hunt Catty & Co. Ltd.	1
University of Nigeria	1

Classified: Trade & Technical

Cox & Danks, Ltd.	3
Edwards, F. J., Ltd.	3
Government Surplus Stores	2
Norris Bros., Ltd.	3
Plint & Partners, Ltd.	1
Research Engineers, Ltd.	1
Straight & Vines, Ltd.	1
War Office Directorate of Disposals	1
Ward, Thos. W., Ltd.	1

Sales and Valuations

Butcher, Henry, & Co.	2
Fuller Horsey Sons & Cassell	2
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For 'Engineering' Appointments Section, turn to the centre of Editorial Section

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Aug. 15	Machine tools and miscellaneous stores	W.D. Storage Depot, Rotherwas, Hereford	Russell, Baldwin & Bright (Dept. J), 10, King Street, Hereford. (Tel. 4366)
Aug. 24	Vehicles, Machine tools and miscellaneous stores, including:	W.D. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire	Dixon & Wallace Ltd. (Dept. J), Bank Buildings, Graham Square, Glasgow, E.1 (Tel.: Bridgeton 2447)

Saloon and estate cars; utilities; vans; 1 to 10 ton trucks (petrol and diesel); 3 and 5 ton tippers; Land Rovers; ambulances; 2 and 4 wheeled trailers; fire pump trailers; tractors; 2,500 gal refueller, road rollers, rotary snow plough; mechanical shovel mounted on diesel tractor; 3 cu. yd. mechanical dumper (diesel); 2 to 12 ton mobile cranes (petrol and diesel); 350 and 500 cc. motorcycles and 1 ton body assemblies. S.S. & S.C. lathes; radial drills; vertical drilling machines; grinders. M.T. spares; batteries; jerricans; lifting gear; lubricating oil; hand tools; tool kits; fire fighting equipment. Water tower components including pressed steel plates; stainless and mild steel sheet, tubes, nuts, bolts and washers; steam and hydraulic valves and packing; boiler house and acid plant spares; acid resisting and fire bricks. Electrical stores; cable; timber; joinery equipment and spares; paint; distemper. Pyjamas; greatcoats; denim blouses; industrial and other clothing; mattresses; blankets; sheets; hessian; webbing; old canvas and leather; camping equipment; tentage; cordage; ropes; curtains; crockery; cutlery; kitchen utensils; office and household furniture, etc.

Aug. 29	Machine tools and miscellaneous stores ...	W.D. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18	Fuller, Horsey, Sons & Cassell (Dept. J), 10 Lloyd's Avenue, London, E.C.3 (Tel. Royal 4861)
Sept. 5	Machine Tools and miscellaneous stores	W.D. Storage Depot, South West Stores, Euxton Lane, Chorley, Lancs. (Sale at Cheetham Town Hall, Manchester, 8)	J. H. Norris & Son (Dept. J), 9 Albert Square, Manchester 2 (Tel.: Blackfriars 8373)

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ENGINEERING Impact

of Observing from London

LONDON this week is deserted. The Royal Family are away in Northern Ireland, the Prime Minister is away in the country, members of Parliament are scattered all over the world, and a great number of ordinary folk, their children released from school (nothing to do with teachers' strikes), have gone away on holiday.

Yet London this week is a splendid observation post. The possible easement of Berlin tension, Major Titov's seventeen orbits, and Britain's preparations for Common Market negotiations —these dominant factors emphasize the enormity of the changes which are occurring to affect Britain's immediate and long-term future. For those now being braced by seaside breezes, the return to factory and office will bring a new bracing influence—the effects of the Government's "little budget." Given a firmness of purpose in high places, for which every responsible person is hoping, Britain will be strong.

There are only two countries in the space race, and Britain is not one of them. Thus from London it is possible simultaneously to applaud the Russians' spectacular progress and to understand the Americans' chagrin. For British engineering, the lesson—if it has not already been learnt—is that no nation can hope to do all things better than other nations. A choice has to be made among the growing number of branches of science and engineering, and thus among all the industries, old and new, which might flourish if each were given the encouragement and Government support which it hopes for.

The effect of joining the Common Market will be to have this sorting-out process thrust upon us, but it will still be necessary for the Government to intervene at various points in the economy, to stimulate one industry and to allow another to lapse. This is a delicate and difficult task for any democratic government. There is little sign yet that Mr. Macmillan's Government have tackled it with vigour. The engineering industries collectively can and do make the greatest contribution to the national wellbeing, but individually they are in for a testing time. The challenge will ultimately be to the individual board of directors of each company. It is the decisions at that level which will make Britain strong.

a New Royal Charter

A ROYAL Charter of Incorporation has been granted to the British Institution of Radio Engineers.

The significance of this is two-fold. First, it gives full recognition to the radio engineer, as distinct from his being only a special form of electrical engineer. This recognition seems to be warranted since the two technologies of radio and electrical engineering are rapidly becoming quite separate from each other; as separate, perhaps, as civil and mechanical engineering.

Second, it means a further diversification of professional authority for engineers as a whole. This development, however, will be greeted with mixed feelings by the growing body who would like to see some form of integration, rather than separation, of the many engineering institutions.

When founded, in 1925, no doubt the primary concern of the British Institution of Radio Engineers was with the science and technology of radio communications. However, electronics, which evolved directly from radio engineering, has now reached even greater stature than its parent science. Consequently, the Brit.I.R.E. must really be thought of as a body of radio *and* electronic engineers. Perhaps this point should be made clear by the renaming of the institution now that it has been granted the honour of Royal Incorporation.

There can hardly be a single remaining area of industrial activity that has not known some considerable advance through the ubiquitous technology of radio and electronics. Thus the granting of a Royal Charter is to be applauded as an act that will further insure industrial progress through the aims of the newly incorporated institution: "To advance the science and practice of radio and electronic engineering."

Unwanted Fire

THAT proverbial bad master—fire—accounted for over £44 million of damage last year, according to the report of the Director of Fire Research. The total number—130,300—was not as great as the 240,000 in 1959 but then about half were on heath or grassland. The cost of fires hardly varied from one year to the next.

Since the war, the Joint Fire Research Organization has been carrying out periodic studies to see whether changing materials and methods are affecting the fire hazards of post-war dwellings. The findings, covering the years from 1947 to 1956, are that temporary post-war dwellings have a rather higher fire incidence at 19 per 10,000 dwellings, compared with 16 per 10,000 for all types (both pre- and post-war). On the other hand an encouraging note is struck by the much lower incidence among permanent non-traditional post-war, dwellings, which have only averaged 8 per 10,000 per year. The report makes no allowances for different degrees of accident proneness of the occupants.

Fires due to electricity have increased roughly in proportion to the increase in its use. Sixty-five per cent of all electrical fires were directly attributable to failure of cable or flex due to chemical or mechanical causes, and not least to sheer age. An interim study on the hazards of oil-burning appliances shows that fires from this cause continue to increase (again with increased use?) but the work of collection and analysis is still not complete.

It is against this background that the JFRO have been carrying out their investigations and researches during the year. They include studies of the ignition and growth of fire (they have found a method for predicting the height of flames) and of extinction and inhibition—which would seem to be a main idea for fire research. Special investigations on building materials have been made on perforated bricks, on dry partitions of plasterboard sandwiches (one achieved full fire resistance for over an hour), on suspended ceilings, and on fibre insulating board, and timber and chip boards that have been treated with various retardants. The number of tests carried out during the year was a record.

Fires due to dust explosions have been investigated at the Station and at Buxton; among the samples of dust classed as most dangerous are polymerised methyl methacrylate, aluminium powders, a bronze powder, and zinc. Research has been concentrated on providing relief for venting systems so that if an explosion does occur, flames or hot gases can be ejected safely.

The full report, which has some impressive illustrations, is called *Fire Research 1960* and is published by the Stationery Office at *5s 6d.*

of a Preference for Metric Screw Threads

IN THE interests of variety reduction, interchangeability, efficient servicing and customer satisfaction, at home and abroad, a number of trade interests and industrial firms—yearning, perhaps for the international accord invoked by wartime necessity—have for some years been worried by the diversity of screw thread practice. Nearly two years ago, one manufacturer published a booklet which, in comparing more than 2,000 standards from 33 countries, underlined the extent of this diversity.

The International Standards Organisation is working on this problem, of course, but it is also important that, trade and industrial interests should concern themselves with the question, for it is one that demands inter-industry and international consideration. The British Electrical and Allied Manufacturers' Association, for example, has been considering the problem of future screw thread practice for some years, and following the decision of the ISO to issue recommendations for both unified inch and metric systems, a detailed inquiry was made among member firms.

Summarizing the results of this inquiry, the BEAMA Council—who, quite rightly, are at pains to point out that these are a basis for discussion rather than cut and dried conclusions—say that there is a significant majority opinion among their members that it is desirable to maintain common normal production practice for the moment, but when the times comes to make a change it should not be to the unified inch thread but to the ISO unified metric thread.

It is not suggested that Whitworth and BA threads have already become less generally acceptable at home and overseas but, if and when the ISO recommendations are adopted, it must be foreseen that Whitworth and BA threads will become obsolescent.

The reasonable inference therefore seems to be that now is the time to start wide and cooperative consideration of what should be their successor, the unified metric thread or the unified inch thread.

This consideration, like the terms of the BEAMA inquiry, should be based on long-term factors, such as the significance of exports to metric and to inch using countries, any existing demand for the unified inch threads, and a forecast of future developments. An interesting point which emerges from the BEAMA survey is that many firms think that, when the time comes to change from Whitworth and BA, the adoption of another inch thread might prove to be merely an interim measure involving manufacturers—and their customers—in a duplication of the great cost and disturbance of this change when they are forced later to fall in with world wide acceptance of a metric thread.

Being only one trade association among many, BEAMA cannot go it alone on a big question of this sort but it would be a pity if their initiative does not develop into a nation wide consideration of the problem. Now that the ISO deliberations make it fairly certain that there will, in fact, be two systems, metric and inch, we have advance notice of the necessity for deciding between the two units. There is time for discussion and agreement now, but there might not be later.

and Getting Young Labour in the New Towns

AFTER ten years the labour pattern in the new towns is about to change radically. So far, there have been very few teenagers available for employment in local industry. By the late 1960's, however, there will be in each of the larger of the new towns up to ten thousand adolescents, most of them available for local employment. The changing form of family life will also mean that there will be a considerable number of married women with grown-up children looking for employment.

The hard figures are given in *The Report of the Ministry of Housing and Local Government for 1960* (Cmnd. 1435 published by HM Stationery Office, *9s 6d*). This year, the report concentrates on the twelve new towns of England and Wales, reviewing the first ten years' achievements and experiences. Because of the abnormal age structure of the new town populations, the number of children reaching school leaving age, expressed as a percentage of the total population, has been and is still below the national average. But whereas the national annual average will settle down at something like 1·4 per cent after the "bulge" has passed, in the new towns the percentage will generally go on rising (in some towns into the mid-1970's) until the figure reaches 2·3 per cent before it begins to decline. Added to this, there will be relatively few retirements.

Local employment therefore can only be provided by the expansion of the existing industries and the introduction of new offices, laboratories and the development of the service industries. Schemes for training young people will be particularly important.

Except at Hemel Hempstead, large office organisations have shown little interest in the new towns until recently —probably because of the difficulty of getting younger staff. But there are now signs that this position is changing.

The report records that, once well started, the new towns have had no difficulty in attracting suitable industry and that their corporations are now in a position to be "fairly selective" about the newcomers.

Liquid Oxygen Saves Space and Weight

The use of liquid oxygen in civil aircraft for the benefit of crew and passengers is only just beginning. It helps to save weight and space and to increase the safety of the aircraft.

IN DESCRIBING details of the Vickers VC 10 recently (ENGNG., 30 June '61, pp. 882-883) mention was made of the liquid oxygen supply system to be fitted. This article describes in more detail the converter system which has been designed and developed by Normalair Limited.

Liquid oxygen converters provide a means whereby oxygen is stored as a liquid and delivered to the user in gaseous form. Such a device means that it is possible to store oxygen much more economically in regard to space and weight, since a given volume of liquid oxygen at atmospheric pressure will generate at least 840 times the same volume in gas. Had the VC10 used a conventional gaseous oxygen system, twelve 2,050 litre cylinders would have been required. These would have occupied 9 cu. ft of additional space and weighed about 200 lb more than the liquid system.

In providing oxygen for both passengers and crew of high altitude civil transport aircraft, it is essential to make sure that the crew is always left with sufficient oxygen to complete a flight irrespective of the demands made on the supply by the passengers. Early converter systems had only a single delivery point provided on the container so it was necessary to use separate converters for the crew and the passengers.

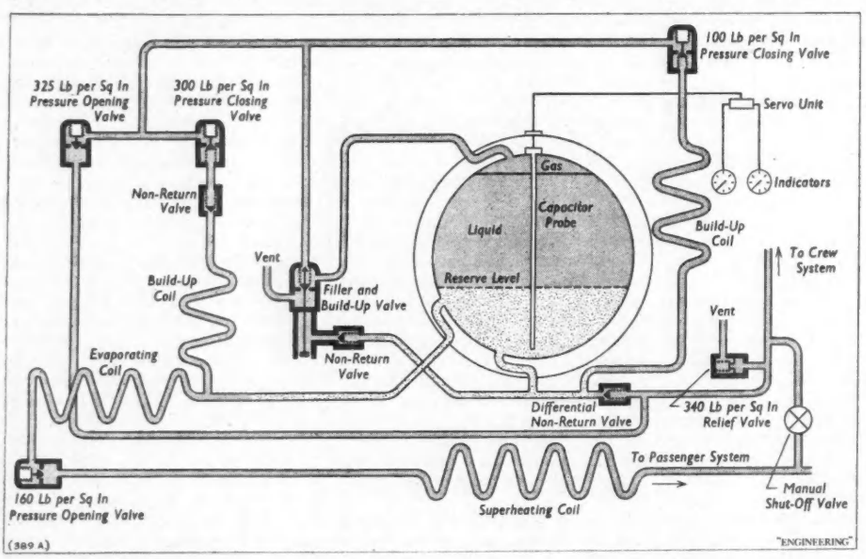
The Normalair system uses a single converter and yet separate supplies can be maintained. This ensures reduced evaporation losses, a more flexible system, less installed weight and reduced maintenance. In addition, crew and passenger supply lines can be linked by a transfer valve in such a way that the passenger supply can be reinstated if the crew decide that oxygen can be made available to the passengers after the reserve level has been reached.

A circuit incorporated in the converter system ensures greater stability of the delivery pressure during flight which also considerably reduces the evaporation losses due to heat transfer. This is achieved by arranging for any excess pressure that might build up above the liquid in the converter during standby periods, or due to temperature influences in flight, to be breathed by the crew until the pressure reduces to the normal working value. When this has been reached the supply to the crew is from the container in the normal manner.

The capacity of the converters ranges from 10 litres upwards—the VC 10 has one 35 litre bottle and saves a weight of over 200 lb. They consist of an assembly comprising a vacuum insulated container complete with its associated control valves. Any desired mounting can be fitted to suit particular installation requirements. To suit specific applications the container may be installed remotely from its control valves.

The oxygen supply system is completed by a combined charging connection and build-up and vent valve, a superheating coil and a capacitance type contents gauge. By associating these items with the converter assembly an empty converter can be replaced by one which is fully charged. This type of installation is most suitable for the smaller sizes of converter. It is current practice, however, to install these items separately and in such installations the charging and build-up and vent valve is generally fitted under the aircraft skin; the changeover from the charging to the build-up position being entirely automatic. Charging is carried out with the converter *in situ* in the aircraft. Only the normal precautions are necessary and the only special equipment needed is to ensure that the liquid oxygen is introduced under a pressure of 20 to 30 lb per sq. in. Because charging is carried out at such pressures the oxygen is much safer to handle.

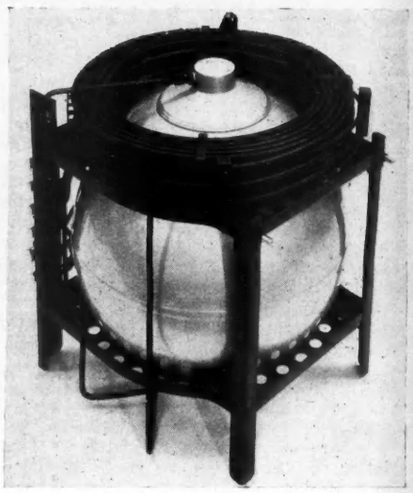
The crew supply is delivered at 70 lb per sq. in and is manually controlled, reducing valves being fitted in the masks. Passenger supply is delivered at 40 lb per sq. in for normal use and 80 lb per sq. in for emergencies. Should for any reason the cabin pressure fail, passenger oxygen masks drop out from recesses in the light luggage racks and are presented within easy reach of each passenger. The system is triggered by a pressure sensing device at the flight engineer's station.



The VC10 is also equipped with "plug in" oxygen sockets at every seat row—in place of the portable bottles currently carried in jet airliners—for passengers who are feeling "off colour." This part of the system and the drop down masks have been developed by the Walter Kidde Company Limited, Belvue Road, Northolt, Middlesex.

Assume that the converter is charged and that the liquid oxygen system is coupled to the aircraft distribution system. The build-up and vent valve is automatically held in the build-up position by spring action. From the container, liquid oxygen passes to both build-up coils where it vaporizes. From the build-up coils gaseous oxygen flows through the pressure closing valves. This pressure gradually increases until 100 lb per sq. in is reached. At this point the 100 lb per sq. in pressure-closing valve closes; the 300 lb per sq. in pressure closing valve remaining open until 300 lb per sq. in is reached, when it also closes.

At this stage, oxygen at 300 lb per sq. in is supplied to the crew and passenger supply systems from the respective outlets in the container. This pressure is maintained unless conditions are such that the liquid level falls below the passenger take-off point when the 300 lb per sq. in build-up circuit becomes inoperative and the passengers continue to receive oxygen from the gas phase until the pressure in the delivery line falls to some 160 lb per sq. in. At this point the passenger line is closed and no further oxygen passes to the passenger system. Oxygen continues to go to the crew at a maintained pressure of not less than 100 lb per sq. in by a build-up circuit associated with the 100 lb per sq. in pressure closing valve.



The Vickers VC10 will be the world's first civil airliner to have a liquid oxygen system. The picture above shows the 35 litre Normalair liquid oxygen converter incorporating a "crew reserve" circuit.

If the system has been in the "standby" position for some time, the system pressure may have risen above 300 lb per sq. in due to absorption of heat by the converter. Under such conditions the pressure opening valve will remain open and a relief valve will prevent the pressure rising above 340 lb per sq. in. Demands by the crew will initially be met via the pressure opening valve until the system pressure reduces.

Continued demand reduces the pressure downstream of the pressure opening valve until at 320 lb per sq. in, 5 lb per sq. in has been established across the differential non-return valve, at which value it opens. Further demand is met from the container by a flow of liquid oxygen, the liquid vaporizing in the build-up coil. A pressure of at least 300 lb per sq. in is maintained on the gaseous side of the container to ensure a delivery pressure in excess of 295 lb per sq. in at all times.

The container's liquid content is shown on one or more indicators by a capacitance type gauge system. The container incorporates a probe unit the functioning of which is not affected by the aircraft's attitude.

Normalair Limited, Yeovil, Somerset.

Humidity Conditioning System

A humidity conditioning system, known as Kathabar, is to be marketed in this country by W. C. Holmes. This system, developed in America, is based on the drying properties of kathene, a liquid absorbent of which lithium chloride is the main constituent.

The advantages of the Kathabar system are said to be: low running and maintenance costs, minimum space requirements, automatic operation, and the supply of air at a constant temperature and humidity. Applications for its use vary from the food industries to marine work.

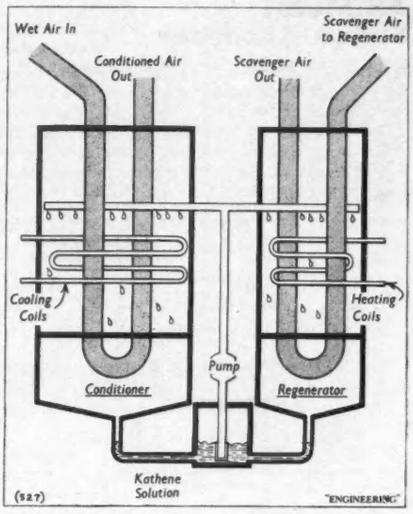
A Kathabar unit consists essentially of a drying tower containing cooling coils, a regenerator tower containing heating coils, and a pumping unit and drainage tank situated beneath the towers. In operation, the kathene solution is pumped to flooding nozzles above each of the two coils. Approximately 85 per cent of the solution flows over the humidity conditioning coil (cooling) while the remaining 15 per cent flows over the regenerator coil (heating).

The air to be treated is drawn into the drying tower where it passes through a dense cloud of kathene mist. The air gives up its moisture to the mist and both are drawn down to the base of the tower. The diluted kathene solution collects in the drainage tank and the air passes on through a drop eliminator to the process room.

Air leaving the unit becomes dryer as the temperature of the kathene solution is reduced and conversely becomes more humid as the kathene solution temperature is raised. Regulation of the solution temperature, therefore, controls the humidity of the air.

The solution flowing over the regenerator coil is heated by steam inside the coil. The heated solution gives up moisture to a supply of scavenger air which is drawn into the regenerator tower from atmosphere: the moisture laden air is then returned to atmosphere. The kathene solution, back to its original strength, is returned to the drainage tank below. Regeneration is therefore conducted simultaneously with and proportional to the pickup of the moisture on the humidity conditioner side.

W. C. Holmes and Company Limited, Turnbridge, Huddersfield, Yorks.



The Kathabar humidity conditioning system is automatic, has low running costs and supplies air at constant temperature and humidity.

Structural Tests on the Avro 748

Since January 1960, tests have been in progress at A. V. Roe and Company Limited to prove the design and structural strength of the Avro 748 aircraft. Firm orders for 21 of these short-to-medium range aircraft have been placed, with options on several more.

Initial tests began with the proving of the aircraft structural details and progressed to the testing of a complete fuselage. In all cases, the ultimate design load was exceeded without structural failure.

Early tests established the strength of fuselage formers and floor beams when subjected to the severe loadings resulting from a crash. Later, a section of the wing, which included the leading and trailing edges, was tested to demonstrate the strength of a typical wing rib both before and after the rib had been artificially damaged. The latter case is an aspect of fail-safe testing.

Testing began early this year on a specimen comprising an engine sub-frame and undercarriage mounted on the local wing structure. Engine and undercarriage loads representing seven design cases were applied and these proved compliance with the Air Registration Board's requirements. During these tests on localized structural areas, an aircraft fuselage complete with wings and tail-pane was assembled in the company's static structural test frame. Simulated tests giving the most severe conditions encountered during take-off, flight and landing began on this specimen in April. Over 1,200 strain gauges were attached to the specimen the results being automatically recorded.

Loads were applied to the structure by hydraulic jacks through a series of linkages designed to spread the load over the whole wing structure to give an accurate representation of flight conditions. This specimen was also constructed with one of the integral fuel tanks in the wing being sealed and loads were applied with this tank full of fuel.

The first tests carried out on this complete aircraft structure was the application of loads to represent the landing case, which controlled the design of the rear fuselage and wing rear spar. This test, the makers say, was cleared satisfactorily.

In June of this year, the principal flight loading case representing an encounter with a 66 ft per sec wind gust was carried out. This case controls the design of the whole wing—in bending moment, and also most of the front fuselage. Loading was increased to 103 per cent of the ultimate design load without failure of the specimen. Later, however, the specimen will be tested to destruction.

Concurrent with the structural test programmes, a schedule of fatigue tests has also been in progress. In August, 1960, a complete cabin structure was immersed in a new water pressure tank at Avro's main works. This specimen was pressurized to a cabin differential of 12·1 lb per sq. in which is considerably more than twice the working pressure required by the airworthiness authorities. The fuselage withstood over 10,000 pressurization cycles.

A complete airframe has now been installed in the water test tank and will shortly be subjected to full scale fatigue testing to destruction. When complete, this programme will determine the fatigue life and the failsafe properties of the aircraft.

Hawker Siddeley Aviation Limited, 18 St. James's Square, London SW1.

Roller Filter for Use in Ducts

A new version of the Autoroll automatic air filter has been introduced by Vokes. Filters of this kind can be built into a duct or similar installation, as would be found in an air conditioning system.

As can be seen from the illustration, the "Mk II Autoroll" consists of a frame which has a roller top and bottom. A clean roll of filtering material is fitted into the top compartment and is taken across the face of the frame, the soiled material being wound up on the bottom spool in much the same way as the now familiar industrial towel. The filter is available in three standard forms, normal flow, reverse flow (with the drive motor on the clean side) and the Manuroll hand operated unit.

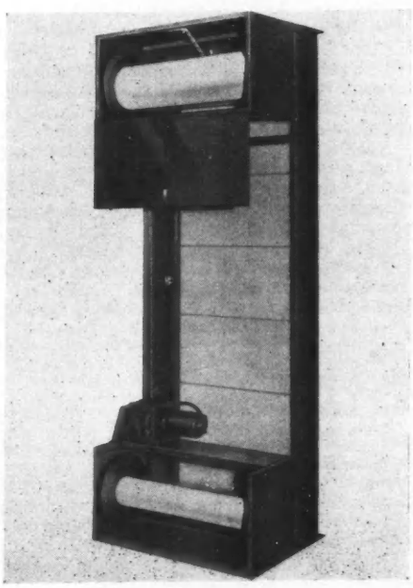
The filter medium is a fire resistant fibrous mat carded to an even density and fused at the intersections, backed by a strong muslin on the clean side to minimise the risk of breakage or local tearing. The inherently good dust collection and retention characteristics of this medium are enhanced by the application of a stablized wetting fluid before spooling. Nominally 125 ft of standard medium can be held in the unit but reduced lengths of heavier media are available for special purposes. The soiled spools are completely disposable.

Intermittent movement of the filter roll is controlled by a pressure differential switch or timer. The pressure switch is normally set between 0·35 and 0·45 in wg. Actuation of the drive unit causes new medium to be inched downwards into the air stream. On approaching the end of the clean medium a lever-operated switch causes a warning light to operate on the control box. An audible alarm can be fitted.

The Manuroll version has a lever which replaces the motor drive unit and a few strokes enables clean medium to be inched downwards. The correct amount of material introduced is assessed by reference to a manometer fitted to the unit or bank of units.

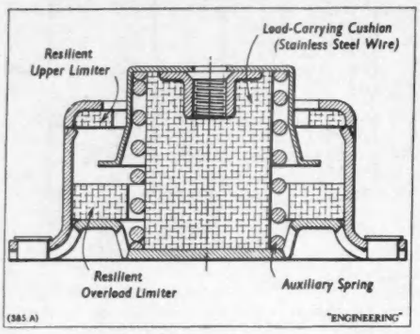
The units are manufactured in standard widths of 3, 4, 5 and 6 ft, and heights vary from 6 to 15 ft in 6 in increments. The frames are constructed in fabricated steel sections, suitably protected against corrosion and designed for erection into multiple banks. A positive side-sealing device ensures that no contaminated air can by-pass the filter.

Vokes Limited, Henley Park, Guildford, Surrey.

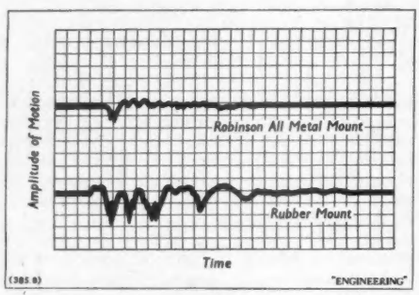


All Metal Shock Absorber

A series of industrial mounts has been developed for superior attenuation of vibration and shock disturbances commonly found in machinery. These mounts, say the manufacturers, provide effective isolation from shock and vibration over a wide range of operating speeds and supported loads with considerable noise reduction ensuing.



The all-metal mount.



Comparative damping characteristics.

Robinson Technical Products, Inc., of America, are the manufacturers but Delaney Gallay Limited, who are the UK licencees, will soon be manufacturing them over here.

The mounts are of all metal construction and incorporate Met-L-Flex stainless-steel fabricated wire cushions. An auxiliary helical spring may be included as shown in the drawing. When necessary, an upper limiter provides gradual engagement for radial or negative motion limitation and shock absorption. The load carrying cushion provides load tolerance and high damping. A resilient overload limiter can be provided for temporary peak loads and shock protection.

The units can be made in stainless steel for corrosion resistance or in Inconel for high temperatures, corrosion resistance and non-magnetic requirements. Because of the all-metal construction they are said to be unaffected by grease, oil, solvents, water, dust or temperature.

According to the type of unit selected, load ranges of from 1¼ to 20,000 lb can be accommodated. The graph shows how the high damping efficiency claimed for the Met-L-Flex mount compared with a conventional rubber mount. The high degree of stability as evidenced by the low magnitude of transient oscillation and the quick return to rest can be seen.

Delaney Gallay Limited, Vulcan Works, Edgware Road, Cricklewood, London NW2.

Research Work on Large Tanker

Britain's largest tanker, the 65,000 ton deadweight Serenia belonging to Shell Tankers Limited, left on her maiden voyage recently to Banyas on the Syrian coast. As well as carrying oil she will be acting as a floating laboratory as she has done throughout her trials.

Members of the British Shipbuilding Research Association have undertaken a programme of measurements in association with the builders, Vickers-Armstrongs (Shipbuilders) Limited. These included measurements of the ship's speed, machinery power output, propeller thrust and stresses in the rudder stock and the sternframe induced by rudder forces. Any vibration of the sternframe due to propeller forces was detected by special instruments.

The trials were particularly important to British shipbuilders as Serenia is the first of a series of ships on which they will be increasingly engaged during the next few years.

When she was in dry dock, BSRA's instruments were fitted and a surface roughness survey of the hull and propeller were made. The strain gauges were attached to previously prepared surfaces using a strong adhesive which was hardened by using infra-red lamps. These gauges, which will subsequently operate under water, are adequately protected from mechanical damage and the ingress of water. In the dry dock, artificially excited vibrations were induced in the rudder with a machine specially designed for such experiments.

BSRA also took part in the steering and manoeuvring trials which were an exacting series of tests to determine her ability to stop or turn quickly under different steaming conditions. The normal speed tests on the Arran measured mile course gave rise to further measurements.

Speed tests were also made by the Decca Hi-fix survey equipment and by ship's log to establish how quickly a large ship of this type accelerates at full speed. Now that she has entered service, recordings of performance data will be made regularly by the ship's officers and sent to BSRA so that her performance over a long period and in differing weather conditions can be studied.

Underwater TV for Suez Canal

Damage is often caused to the cutting teeth of canal dredgers by submerged debris and the delay in repairing them is both costly and time consuming.

The Suez Canal Authority believe that much of this damage will be eliminated with the installation of underwater television and they have ordered a full set of Marconi-Siebe, Gorman equipment. It will be used to examine the underwater condition of the Canal and the entrances to Port Said and Suez Harbours. In addition, more accurate control of the dredging operations will be provided.

At present, when submerged parts of vessels have to be examined, the work is carried out by a diver without technical supervision. By using underwater television equipment a specialist engineer will be able to examine on the monitor screen the damaged area of the vessel and supervise the work accordingly. He will also be able to pass instructions to the diver by using the telecommunications equipment provided as an ancillary to the camera and the monitor equipment.

Work is now going on to allow television cameras to be fitted to the keels of vessels passing through the Suez Canal so that a constant watch can be kept on the clearance of the keel during the passage through the Canal. This avoids any possibility of running aground, especially in the narrow sections.

The Marconi-Siebe, Gorman underwater television equipment is primarily a hand-held apparatus with overall dimensions, including casing and lamps, of only 3 ft by 2 ft 3 in. The camera can be buoyancy adjusted for virtual weightlessness under water. The North of Scotland Hydro-Electric Board are using a similar camera for research into fish and hydraulic problems on Scottish lochs.

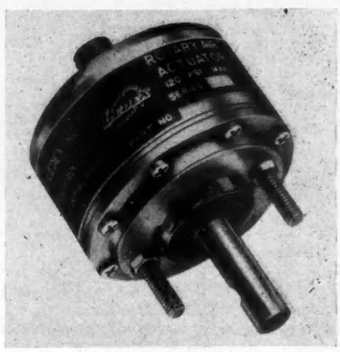
Marconi's Wireless Telegraph Company Limited, Chelmsford, Essex.

Miniature Pneumatic Rotary Actuator

A small, medium speed, pneumatic rotary actuator has been announced by NSF Limited which is said to make possible the economical control of a variety of machine tools and operations.

It operates on the principle of the conversion of linear to rotary movement through a system of balls running in suitably inclined races. The integral rotary shaft, the driven member, can be directly coupled to the load, thus dispensing with costly linkages.

A feature of the actuator is the high torque output for its size. The illustration shows the



This actuator has a high torque output for its size.

series 50 measuring 1½ by 2 in which provides a torque output of 6·5 lb in for a maximum operating air pressure of 120 lb per sq. in and 90° output shaft rotation. Available shortly will be a range developing torques of between 1·35 and 94 lb in. The makers say that torque is uniform right through the rotary stroke, no compensation being necessary as in the case of an electrically-operated solenoid.

Speed is dependent on the load. Normal actuating time for the size shown without load at 120 lb per sq. in is 30 to 40 milliseconds for completion of the 90° stroke. Due to the low displacement the speed response is high. For the series 50 air displacement is 0·16 cu. in and piston stroke is 0·78 in.

All working parts are enclosed but shaft seals are not employed; thus there is little to deteriorate or wear. Special air line arrangements are unnecessary as the unit is self lubricating.

NSF Limited, 31-32 Alfred Place, London WC1.

Britain's largest tanker, the Serenia, also acts as a floating laboratory.

Plain Words

By Capricorn

WHICH is the subject that all engineers study but most of them forget; that is precise yet poetic; that is essential to engineering yet can be studied without any reference to engineering? There are no prizes for picking out mathematics.

It is the snob subject *par excellence*. If you don't know the language of mathematics, or even if you have simply forgotten it, you are cut off from the lofty thoughts of those to whom it is familiar symbolism. When the mathematician has expressed a phenomenon in an equation he has the comfortable feeling he understands it fully and finally. In this respect he is almost certainly mistaken, but it gives him a degree of one-upmanship which the non-mathematician cannot hope to demolish. At school, when you plot the height of high tide at the estuary bridge every day for a month, and you produce a beautiful curve, you experience a sense of revelation of the mysteries of the tides. It is only later that you have a greater revelation—that there must be innumerable and unimaginable equations which determine the fall of rainwater in the catchment area, its flow down the river, and its meeting with the ungovernable sea—" far back through creeks and inlets making, Comes silent, flooding in, the main." Then, if you have kept your mathematics in trim, you may experience a wild ambition to formulate all those unknown equations.

For mathematics is like golf—it's fun so long as you practice it often enough, but it's hell if you let it go. It allows you to play the great game of " If." Let x equal y, we say, and all sorts of wonderful possibilities flow from such a supposition. The basic mathematical philosophy that however the variables vary, the left-hand side of the equation will still equal the right-hand side, is very attractive in a world where everything is always annoyingly changing. An equation is the constant truth about changeable factors.

Just as primitive men worshipped the sun, so might we worship mathematics. Most of us could be described as lapsed mathematicians, but we can still revere its power—and get a real mathematician to solve our problems. One of our largest engineering groups is evidently alive to its importance, especially mathematics of the simple sort. The education department of Associated Electrical Industries (Manchester) Limited have produced an admirable brochure describing some visual aids for teaching simple arithmetical, algebraical and geometrical relationships. It is based on some cunning devices which are used in the Siemens and Halske works school in Berlin. In a foreword to the brochure, Sir Willis Jackson remarks that the devices are easy to construct and that the education department will be pleased to supply further information.

I have half a mind to make them up myself and get back that old black magic.

Letters to the Editor

Two-Element Fluid Couplings

SIR, Before replying to Mr. J. Bilton's letter (ENGNG., 30 June '61, p. 885) may I point out that in my original letter (23 June '61, p. 853) I used, in two places, the expression (100-speed factor). This was printed as (100 × speed factor).

The results that appear below are based on the use of the expression (100-speed factor). What appears to Mr. Bilton to be the " fundamental flaw " in my letter is, in fact, no flaw at all.

Those readers who have studied—at what one might call an " adult " engineering level (as is used by Den Hartog in his *Mechanical Vibrations*)—the action of the two-element type of fluid coupling, and have applied the Law of Conservation of Mass, or, as the oil may be considered incompressible, the Principle of Continuity, know that, in basing my considerations on power, I included all those factors that are functionally related to power.

In the runner these factors are the torque exerted on the runner, and the angular velocity of the runner. The tangential force component of the torque—Coriolis force—is a function of the mean radial velocity of flow, inwards, of the oil in its passage around the vortex. And this mean radial velocity of flow is a function—an inverse function—of the angular velocity of the runner.

By relying on the validity and applicability of the Law of Conservation of Energy I was able to deal with the subject solely from considerations of power, considerations familiar to the vast majority of the readers of this publication. My approach to the subject was not quite so naïve as Mr. Bilton seems to infer, and to imply.

In pointing to an alleged—though non-existent—fundamental flaw, Mr. Bilton may have diverted the attention of readers from the particular case I cited, that had reference solely to the two-element type of fluid coupling. I will return to that.

The manufacturers of a two-element fluid coupling, who have been making this type for many years, publish a bulletin in which appears an illustration of their product as included in a particular transmission. The caption states that, although the runner is completely " stalled," the impeller is still rotating at its maximum torque rpm.

Let me analyze the action for varying torque demand by the method I gave in my original letter. Here are the results, based, of course, on the assumption that the " loss " conforms to that which is usual:

Percentage power supplied	100	100	100
Percentage torque demand	200	140	100
Corresponding percentage speed factor	0	60	98
Percentage useful power transmitted to the driven load	0	84	98
Percentage power " loss "	100	16	2
Percentage power efficiency	0	84	98
Torque ratio	2/1	1·4/1	1/1

In the above it should be noted that when the runner is stalled at zero speed factor it does not move, thus it does no work, transmits no power. The power efficiency of the coupling is zero. All the power supplied by the impeller is being absorbed in internal loss. Though the runner is stalled it exerts a torque: twice the maximum torque exerted on the impeller. As the torque demand falls, the speed factor increases, and the torque ratio decreases. The torque ratio reaches its minimum value of 1/1 when both the speed factor and the power efficiency reach their maximum values of 98 per cent. The variation in torque ratio from 2/1 to 1/1 is continuous and smooth.

The fact that a two-element fluid coupling will make the best use of the power available, whatever may be the torque demand of the load, by an automatic change in speed factor to suit the torque demand, is what makes it a desirable element in a transmission. It gives flexibility to the transmission, whereas a straight-through shaft would give only inflexibility, or an invariable torque ratio of 1/1.

The use of such phrases as " the torque ratio remains invariable at 1/1 " and " action and reaction are equal and opposite," without any regard to what the type of fluid coupling may be, or what the power-efficiency may be, is evidence of faulty generalization. And so is insistence that " in *any* rotary hydrodynamic device torque conversion is not possible without the use of a stationary reaction-member."

Yours faithfully,

G. MONAGHAN.

London.
18 July, 1961.

Events in Advance

Small Firms Study Instrumentation Aids

A ONE-DAY conference on instrumentation, of more than ordinary interest, is being organized by the Society of Instrument Technology and will be held at the College of Technology, Loughborough, on 13 September next.

The general theme will be " The Application of Instrumentation to Industrial Processes," and the Society are hoping to attract delegates from engineering firms throughout the East Midlands area, especially the small users of instruments such as flow, humidity, temperature, level and pressure metering, and equipment for determining such aspects as colour comparisons and fastness.

It is felt by the promoters that, in many of the smaller concerns, these matters are discussed, often in some detail, but that steps are not always taken to install the apparatus and techniques which will ensure the greatest efficiency and productivity. Demonstrations at the conference will take the form of working displays presented by the same persons as are giving the lectures and will not follow the more usual procedure whereby manufacturers exhibit their apparatus out of context and staff the stands with their own salesmen.

At this meeting, members of the Society will serve as stewards and will be available throughout the day to discuss queries and give advice. Among other subjects lectures will be given on mechanical handling, colour changes on exposure to light, temperature control, and flow and level control. A session will be devoted to case histories.

Additional information may be obtained from the honorary secretary of the Society's East Midlands Local Section, Mr. A. C. Baker, c/o The English Electric Company Limited, Whetstone, Leicester, or by telephoning Narboro' 3434.

Exhibitions and Conferences

Arranged in chronological order

Aircraft Exhibition and Convention, First International.—Tues., 29 Aug., to Sat., 2 Sept., at Luton Municipal Airport. Exhibition director: Mr. John Todd. Organizers: Commercial and Technical Exhibitions, 1 Crane Court, Fleet Street, London EC4. Tel. FLEet Street 0657.

Noise Measurement Course.—Mon., 11 Sept., to Fri., 15 Sept., at the Royal College of Advanced Technology, Salford. Emphasis will be on practical measurement and the use of typical instruments. Apply to Mr. Peter Lord, Royal College of Advanced Technology, Salford 5, Lancashire.

" Manchester Evening News " Food, Cookery and Catering Trades Exhibition.—Tues., 12 Sept., to Sat., 23 Sept., at the City Hall, Manchester. Organized by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester 3. Tel. Deansgate 6363. (Note: The correct title of this exhibition is as given here and not as previously stated).

Machines that Sort Signals from Noise

Electronic equipment working on a learning principle can detect signals hidden by noise. Two machines may be developed to analyse economic systems.

ONE of the most remarkable things about the human brain is how it operates with the sense organs to form a filter. The various sounds entering the ears, for example, can be separated out in a most flexible manner. Notes of different pitch can be easily distinguished by most people—this is referred to as linear filtering. Or—to give an example of a more complex process, non-linear filtering—a piece of music or conversation can be picked out against a noisy background.

This latter property, the ability to pick out the significant part of a mixture of signals, is something that intrigues the electronic engineer greatly. It is fairly easy for him to build linear filters to separate signals according to frequency; but non-linear filters are a different matter. For one thing, no formal mathematical solution has been found to the problem of designing the best non-linear filter for a given situation.

Yet electronic non-linear filters could have very useful industrial and military applications. In this respect they can be compared with the electronic digital computer. Computers, by their enormous speed of repetitive calculation, prove to be of great use for solving problems that man just does not have time to cope with. That is, computers extend man's ability at arithmetic. Similarly, it is felt that electronic non-linear filters could be designed to extend man's ability to pick out the significance of series of events.

At the General Electric Research Laboratories, Schenectady, New York, work is in progress on a device that will notice if there is a signal hidden in noise. It is possible that this would be of great value in submarine detection. Operators can sit for hours at a sonar set listening to the collection of noises coming out of their receiver and not know of the presence of an enemy submarine, because the signals from it are buried under the general noise level. If the nature of the signals is accurately known—for example, if they are reflections of signals sent out from the listening post—then it is possible to use techniques that increase the power of the received signals, adding them together to bring them above the noise. But if the nature of the signals is not known, this cannot be done.

The equipment being developed by C. V. Jakowatz, R. L. Shuey, and G. M. White is intended to pick out signals hidden by noise even when their character is not known. In this way the range of submarine detection equipment might be much increased. In fact, the task of recognizing significant signals would be taken over from the operator by the machine, which would have greater sensitivity and no susceptibility to fatigue. Similar equipment could possibly be used for the interception of radar signals or messages hidden by noise.

The authors point out that their equipment is capable of pattern recognition of a restricted type. As such, it is a step towards more general pattern recognition systems. "It should be a very useful device if one-dimensional patterns are to be detected. However, work remains to be done in other broad areas of the pattern recognition field. It is hoped that these concepts used in the machine can be extended to the generalized problem of recognizing a pattern rotated or translated anywhere on a two-dimensional plane."

An important feature of the machine being developed at General Electric is that it is an adaptive filter—it learns what it is looking for by a system of trial and error. Thus the mathematical difficulty of designing the optimum non-linear filter is bypassed—the machine designs itself. This short cut through the difficulties of designing non-linear filters was put forward in 1954 by Professor D. Gabor, Imperial College of Science and Technology, London.

Development of a learning filter started there two years later and the first results with the machine have recently been published ("A Universal Non-Linear Filter, Predictor, and Simulator which Optimizes Itself by a Learning Process," by D. Gabor, W. P. L. Wilby, and R. Woodcock, read before the Institution of Electrical Engineers). This machine differs from the one being developed at General Electric in that it is not self-teaching, but can be taught.

"One can assess what a non-linear filter backed by a large memory can do," write Professor Gabor and his colleagues, "by noting that our ear-plus-brain is such a filter, which, as everybody knows, can perform near miracles in separating music or conversation from a noisy background. The prediction of complicated stochastic processes may well be one of the most important contributions of electronics to the solution of problems of great human importance in economics, sociology and other fields."

They suggest that the range of applications of such a machine goes far beyond what is suggested at first sight by the word "filter." Recalling that noise can be defined as any sound that is not wanted, they point out that if the machine can single out certain communication signs, it can also at once recode them into other signals so long as there is a sufficiently unequivocal correspondence between them. "This line of thought leads without any logical break to applications such as speech recognizers and even translators, but it must be pointed out that, as one approaches higher functions of human intelligence, the complication of the machine is likely to increase at a prohibitive rate."

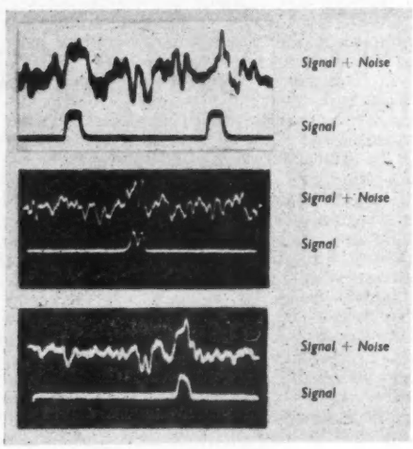


Fig. 1 Recognizing signals hidden in noise is one of a number of applications of non-linear filters.

An application of the learning filter of great potential interest is as a universal simulator. This has been suggested by Professor Tustin. There exist systems of great importance, such as large petrol refineries or the British economic system, which for obvious reasons cannot be submitted to experimental tests, however important it may be to know their behaviour in certain contingencies. On the other hand, data on their inputs and outputs are available over long periods. If one puts these into a learning filter with the instruction "produce the second set out of the first," the machine will make itself into a model of the system and the experiments can then be carried out on the model.

HIDDEN SIGNAL DETECTOR

The General Electric equipment is a simplified experimental model designed to form a representation of certain types of regularly occurring waveform appearing at its input. Later machines will be developed to recognize a number of different waveforms at the same time. This will be done by duplicating the channel used for one waveform the appropriate number of times.

A single channel of the machine works as follows. It has ten storage units termed long-term memories. The object is to obtain a representation of the hidden signal in the long term memories. The representation is thus made up of 10 components. For example, if the two end channels contain no signal and the eight inner channels contain a uniform high voltage, a rectangular wave would be represented.

To measure the degree of success with which the synthesized signal represents a hidden waveform, a short term memory is included which splits the incoming signal into a similar ten components. Arithmetic circuits continuously compare the 10 components in each of the memories to determine how much alike they are.

To start with, a random sample of the incoming signal—which may be the hidden waveform plus noise, or simply noise—is transferred into the long term memory. A continuous check is then made between the incoming signal and the contents of the long term memory. When the two components are sufficiently alike, they are averaged by another circuit and the average is used to replace the original component in the long term memory. As this process goes on, any regularly occurring waveform will be reinforced in the memory, but random noise will not. If after a certain time, no averaging operations take place the machine clears its long term

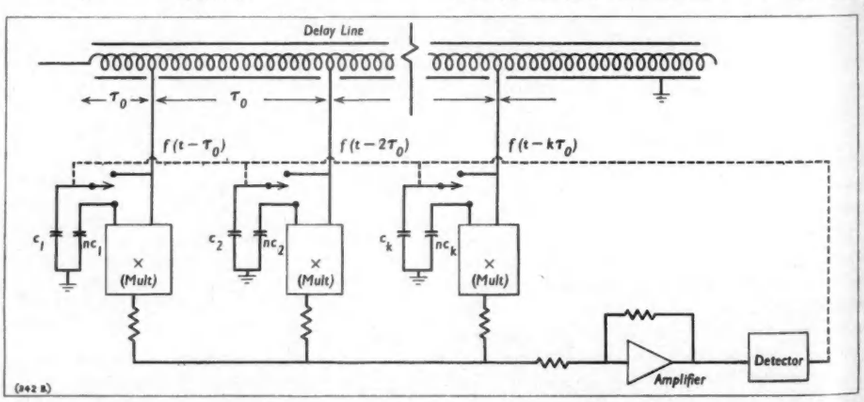


Fig. 2 The basic circuit of the American General Electric filter. It has proved superior to a human operator in the detection of certain signals.

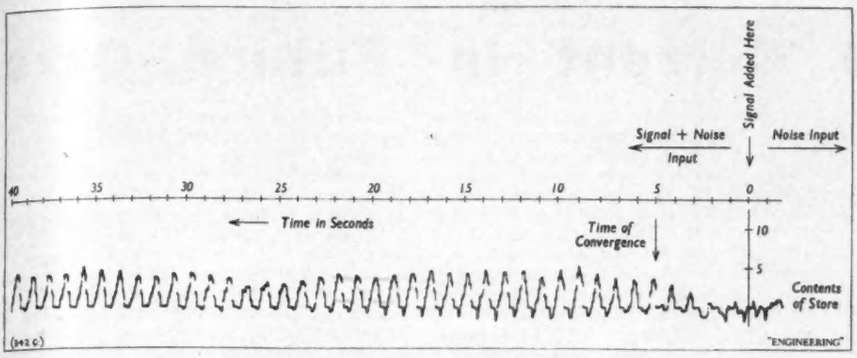


Fig. 3 How the picture of a signal grows in the GE machine. After about 5 seconds, in this experiment, a fair representation of the waveform is obtained.

memory, deciding that it probably only contains noise, and takes another sample.

This idea of arbitrarily selecting samples of waveform in the hope of obtaining a signal is one of the basic principles in this type of recognition system. The second basic principle is that it is possible to coherently average the components of the hidden waveform while those of the noise are incoherently averaged.

Suppose the following four conditions occur: (1) a waveform is initially deposited in the long term memory, (2) the decision circuit detects correctly many times the occurrence of the corresponding signal in the input, (3) the components of the signal in the long term memory and the input are aligned when the new information is transferred into the memory, and (4) the new waveform that is added into the memory is deposited in such a manner that its weight in determining the average output from the long term memory is equal to each of the waveforms previously deposited. If these conditions are met, the long term memory will form a better and better estimate of the structure of that particular hidden waveform. By weighting the average in favour of the more recent deposits into the memory, the system is able to follow gradual changes in the waveform.

The actual type of circuit used is shown in Fig. 1. Long term memories are provided by the condensers $n\,c_1$, $n\,c_2 \ldots n\,c_k$. The condensers c_1, $c_2 \ldots c_k$ serve as sampling condensers of the incoming information from temporary storage provided by a tapped delay line. An interesting feature of the circuit is that relay switching associated with the condensers provides the averaging operation. Multipliers are incorporated so that the correlation between the incoming signal components and the stored components can be determined. When the correlation coefficient exceeds a certain value, as sensed by the threshold detector, the appropriate relay is actuated and the averaging process is carried out.

The simple experimental system using 10 memory stores has required a higher signal-to-noise ratio to detect a signal than was expected, but performs better than a human operator using visual and auditory presentation of the input.

UNIVERSAL SIMULATOR

The Imperial College machine is the realization of a highly flexible mathematical operator. In this case 18 samples of signal are taken and multiplied together in various combinations: one at a time, two at a time, three at a time, etc. Each product so formed is multiplied by a coefficient and the whole series is added together. Eventually there will be 96 variable coefficients in the machine, provided by 96 potentiometers. The principle the machine is based on is that the process of forming such a polynomial with adjustable coefficients transforms the original waveform into any other desired waveform. If, for example, only the sum of the simple products of the original samples and coefficients are considered, then the process represents linear filtering. As higher and higher order terms are considered, involving the multiplication of greater numbers of samples together, so the effect becomes more and more non-linear. The number of potentiometers for providing coefficients for such terms gives an indication of degree of non-linearity that the filter can simulate. The number of samples taken of the signal indicates the bandwidth of the signal.

The transformed input signal as it leaves the filter is compared with the signal it must be transformed to—called the target function. Thus the input signal might be a record of the input to an oil refinery and the target signal would be a record of refinery output. The aim is to adjust the potentiometers (the coefficients of the polynomial) until the output of the filter for the given input corresponds to the target function. The filter can then be taken as a model of the refinery and experiments carried out on it to predict how the plant will behave.

By attaching comparison circuits to measure the degree of success with which the filter output represents the target function and feeding back this information to a control mechanism adjusting the potentiometers, it becomes possible to make the machine adapt itself to a closer and closer representation of the process.

In analogue machines of this type the design of the multiplication circuits presents problems. Where large numbers of such circuits are required, conventional commercial equipment tends to be too bulky and expensive. For the Imperial College machine a piezo-magnetic multiplier invented by Dr. W. P. L. Wilby proved most suitable. A prototype unit measures only 1 in diameter by 1¼ in long, and is driven by one double triode valve.

So far, only the results of tests on the linear part of the filter have been published. In an experiment to examine its ability to filter a sine wave from noise, the machine required 10 teaching runs to reduce the mean square error between the output and the target function to about 10 per cent. The amplitude of noise power was adjusted to be equal to that of the sine wave power and the two were added together to produce the composite signal.

The machine is now being built up to the full capacity of 96 terms. Other work in hand includes the construction of input equipment to enable the machine to operate on statistical material contained in tables, graphs, or non-standard tapes. Also the learning process is to be automized completely.

Both of the machines described could have been replaced by a digital computer. The decisions to construct the filters were taken because it was felt that the programming and machine time required on a digital machine would make the process uneconomical. Furthermore, both teams wished to obtain a better appraisal of the components that might be required in a system designed for use as an adaptive filter. The development of the piezo-magnetic multiplier is a significant step in this respect. The General Electric machine used commercial multipliers and the team acknowledge that at present "our greatest need is for a cheap four-quadrant multiplier."

It may well be asked if the process carried out in the Imperial College machine could not be shortened by extracting the statistical parameters from the sample, which in principle could be done in one run, and feeding these into a digital computer which will solve the 100 simultaneous linear equations for optimum coefficients. The large digital computer at the Cambridge Mathematical Laboratory requires only 7 minutes to solve 100 simultaneous equations.

Digital computers are very complex and expensive. For a practical situation, such as the detection of submarines, it would be much more reasonable to take on to a ship a machine such as that developed by General Electric than to take a large digital computer.

In its present form the Imperial College machine is quite large. But it is the teaching apparatus, including the tape deck, which forms by far the greatest part of the whole assembly. The intention is not to use this machine in practical applications but to use it for developing prototypes of linear and non-linear filters. These would not be self-adaptive but would have their instructions in advance. They would then be quite small and light.

The General Electric machine promises to be very compact. Use of the Imperial College multipliers would probably reduce its size still further; and a considerable amount of thought has been given to replacing the relay switching by diode switches. A machine dealing with signals characterized by 15 samples is now in operation. This was recently seen by Professor Gabor. "I was really impressed with its operation," he writes in a letter to our correspondent. "In about one second it had abstracted a new signal hidden in noise to a perfection which beats any human operator." Model experiments to determine the feasibility of machines using up to 145 samples, so handling more complex signals, have been made on digital computers.

Thus there is the distinct possibility of developing very compact units capable of carrying out specific tasks of recognition. These would operate in real time and would carry out operations that would normally require quite a large digital computer. This is the attractive possibility held out by the adaptive non-linear filter.

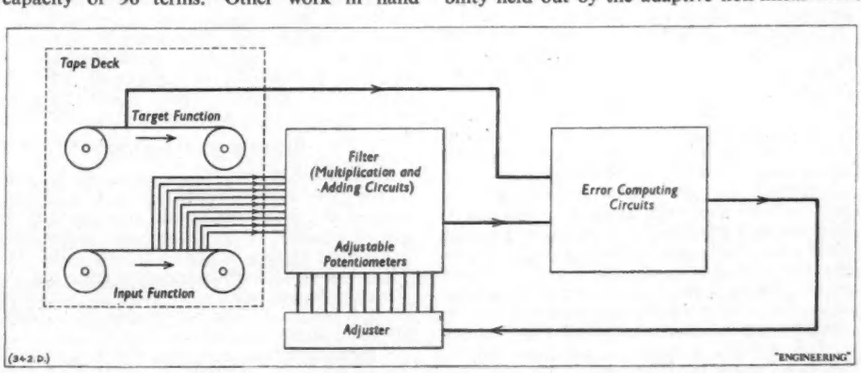


Fig. 4 The Imperial College machine is for general studies of linear and non-linear filters. Various special machines may be developed from it.

Providing the Current in Future Cars

The lead-acid accumulator is the most widely used battery in cars today. What are the possibilities for the future?

BATTERIES have kept up with the increasing electric power needs in cars. In fact, the extra power needed to start larger engines, to feed high-wattage lamps, to supply extra accessories is still obtained from the same type of battery as it has been for the last 40 years. But many alternative batteries have been developed in this time, for other uses. Are some of them likely to oust the lead-acid accumulator as car electrical loads increase still more? Looking further ahead, when will a battery be produced that will replace the internal combustion engine altogether—making the quiet, smoke-free electric car available to the ordinary motorist?

Various answers to these questions have been given in recent months by battery manufacturers. They agree that the lead-acid battery will remain the only suitable electrical storage unit for the normal car. As far as electric cars are concerned, city traffic sees them at their best, but the need to spend appreciable time recharging the battery limits their range and availability. The gas battery, or fuel cell, could change this situation radically. But manufacturers consider that speculations on the economics of such cars cannot be made until about five years time, when they may be looked at as an engineering probability rather than a scientific promise.

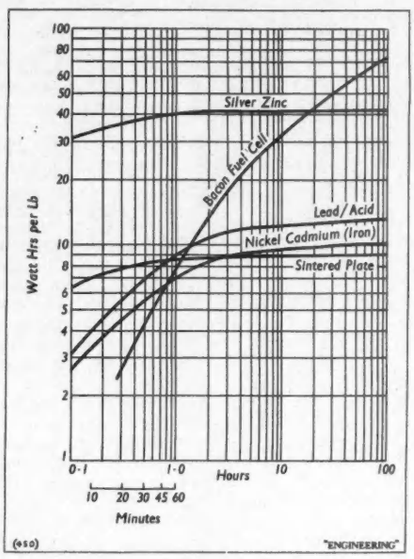
NICKEL-CADMIUM

Lead-acid batteries have improved much in recent years. Dr. Barak, Chloride Electrical Storage Company Limited, has pointed out that the standard motor car battery now gives as much as 20 per cent more watt-hours per pound than its counterpart of about 10 years ago. He also claims that its average life is considerably longer, in spite of the increased loads it has to handle. In the traction field, improvements have also been made: modern batteries for electrically-propelled vehicles are said to be at least 30 per cent lighter than they were five years ago. This has been largely due to the use of the new fabric type of tubular plate.

Estimates on the improvements possible in the lead-acid battery vary. Mr. J. J. Lander, Delco-Remy Division, General Motors Corporation, suggests in an SAE paper that the battery engineer has about 90 per cent of the information necessary for him to do his work, and that consequently very minor advances in performance are to be expected by way of engineering design. The electro-chemist is in the same situation. His problems are well defined. Substantial improvements in the use of active material must come by way of basic studies, which would seek to increase the surface area of active materials, to make possible the use of acids of higher specific gravities, to decrease the high proportion of grid weight, and to enable better charging at low temperatures. He considers that an overall 10 per cent gain would represent a substantial advance in performance.

Mr. C. G. Grimes and Mr. W. S. Herbert, Electric Storage Battery Company, in another SAE paper, consider that most of the improvements in lead-acid batteries have been the results of incremental improvements, as opposed to any profound advance that could be attributed to research, and that the latter has been somewhat neglected. "One seldom hears any reference to the electro-chemical efficiency of the lead-acid battery," they write, "this is quite understandable when, after a hundred years of development, the efficiency is about one-half of what it could, and should be . . . we fully anticipate that the advance in the technology of the lead-acid battery will be greater during the coming decade than during the past half-century."

The nickel-cadmium battery, or alkaline battery, qualifies as the best secondary battery in terms of all-round performance. At low temperatures and high rates of discharge it is especially good in comparison with the lead-acid battery. It yields about three times the energy per unit weight at 0° F, and will accept charge as fast at 40° F as at room temperature. It is extremely rugged and long lived, and is capable of sealed operation. Mr. Lander suggests that its weight performance is capable of increase by perhaps 25 per cent by an all-out attack on its engineering and electrochemical problems.



At high rates of discharge the fuel cell becomes inconveniently large, and so it is unlikely to be used for starting car engines.

Dr. Barak points out that modern alkaline batteries for electric traction are at least 15 per cent more powerful than their predecessors; and about 25 per cent more power is obtained from the modern alkaline diesel-starting battery than could be realized from similar batteries of the same weight only 10 years ago. The recent development of thin plates made of highly porous sintered nickel has offered even more spectacular increases—at the 5 minutes rate of discharge a sintered-plate battery will provide a wattage well over twice that of a conventional alkaline battery of the same weight.

Unfortunately, the nickel-cadmium battery is not a feasible proposition for car use. There is not enough cadmium to go round. Mr. Grimes and Mr. Herbert estimate the amount of lead used annually in the United States for the electrochemically active component of lead-acid batteries at 114,000 tons. They estimate that about 31,000 tons of cadmium would be required annually for batteries to replace the lead-acid type. This represents about three times the world's annual production of the metal.

SOLAR BATTERIES

Automotive batteries account for 90 per cent of the lead used in batteries. In fact, battery usage today is so widespread that any battery system which is to be widely used—such as in cars—must employ materials that are plentiful. Thus, the silver-oxide-cadmium battery and the silver-oxide-zinc battery, while giving very high outputs per unit weight, do not compete with the lead-acid battery for car use.

Claims have been made recently for a battery-driven car in which the battery is charged from the output of solar batteries in the roof. The solar batteries are similar to the sensitive elements used for photographic light meters. They release electrons when illuminated by light. Dr. Barak comments that these can hardly compete with established traction batteries (for which the capital cost would range from 3*s* per watt for lead-acid to about 6*s* per watt for alkaline while their estimated capital cost remains at £50 per watt.

Nuclear batteries are in an even higher price range. SNAP III, in which a small pellet of radioactive polonium 210 heats a number of thermocouples, has an output of 5 W, a weight of 5 lb, a life of 140 days, and a cost of about £10 million.

FUEL CELLS

Fuel cells are batteries which have their active materials continuously fed into them. Generally the materials are gases. As far as electric cars are concerned, these cells offer the possibility of recharging, much in the same way that petrol driven cars are recharged with petrol. That is, the recharging process of 6 to 12 hours associated with battery cars at present is avoided.

Batteries can be said to be made up of the following components: cell container or reaction vessel, conducting electrodes, electrolyte, reactants, and separators. Fuel cells have these components (although the separators are absent in some cases), and also need storage vessels for reactants, pumps or circulating equipment, auxiliary heating equipment, and some means of effluent disposal. Dr. Barak explains that, to obtain a realistic comparison of the outputs per unit weight, the weight and volume of all components must be included. However, it is difficult to obtain details of all components from published accounts of fuel cells, and realistic comparison of the claims for various types of cell is difficult.

Without regard to fuel economics, and restricting the comparison to power output per unit weight, Mr. Lander considers that the hydrogen-oxygen fuel cell can be said to be approaching a competitive position with the diesel engine, because it requires a performance increase by only a factor of two or three, if the power rating of a diesel engine is accepted as being about 75 W per lb. It still has a long way to go to become competitive with the petrol engine, at about 250 W per lb. He considers 10 to 20 W per lb as obtainable in present cells.

Dr. Barak gives similar figures for the energy densities of hydrogen-oxygen cells, but points out that achieving such densities calls for pressures of about 600 lb per sq. in and temperatures of about 200° C. Such conditions raise certain disadvantages in a portable power system, as does a cell with a comparable output, using liquid oxygen and solid lithium hydride.

Mr. Grimes and Mr. Herbert find that few of the claims made for fuel cells can be substantiated by data on actual performance. They believe that the fuel cell, in general, will create its own markets as an extension of battery applications, rather than as a replacement.

Dr. Barak summarizes the energy outputs from various batteries in the graph shown above. He considers that fuel cells are unlikely to compete with engine-starting batteries. If their early promise is fulfilled they may be used in sizes above 100 kWh for driving electric locomotives.

So the prospects for the electric car are that in the next few years it can expect little in the way of greatly increased range from innovations in battery technique. If, however, this form of transport—so well suited to city traffic conditions—was thought generally desirable, it would be possible to improve the charging equipment at garages. If a charger of sufficient capacity and adequate power is available, vehicle range (10 miles, say) can be increased by 60 per cent by charging the battery during a one hour lunch break.

Human Element

Redundancy and Technical Advance

AT THE recent Harrogate conference on economic and social implications of automation, it was agreed generally that the cost of redundancy compensation and re-training of operators is an integral part of any capital investment plan involving technical advance. The importance of a recognized policy on redundancy procedures is underlined again by a new Ministry of Labour booklet, "Security and Change—Progress in Provision for Redundancy," prepared with the help of the National Joint Advisory Council.

In his foreword, the Minister writes, "The worker cannot be expected to develop a sense of corporate loyalty . . . without some assurance that the firm accepts responsibility towards him in changing as well as in stable times. Yet if industry is to develop and grow, changes must occur from time to time and this makes it impossible for the employer to promise a job that will continue indefinitely. Much needless anxiety and misunderstanding can be avoided if both sides . . . agree to provide in advance against it."

The booklet describes procedures which have been adopted in private industry to meet particular circumstances such as the closing down of a factory, and also gives examples of arrangements made in the nationalized industries and of other arrangements recommended by employers' associations.

Forward Looking

More interesting and more important still, however, are examples of 236 policies adopted by private companies and groups of companies for general application to all cases of redundancy which might arise in the foreseeable future. It is this type of forward-looking policy—rather than one of *ad hoc* measures after the horse has bolted—which is necessary to create a climate of security and cooperation at a time when management and managed alike cannot be unaware of the possibility of technical developments disrupting traditional social patterns.

Examination of the 236 policies of individual firms showed that about three-quarters of them contained arrangements for consultation with employees' representatives in the event of redundancy; about a quarter referred to measures that the companies would take to support the required level of production in order to keep dismissals to a minimum, and four out of every five stated that recruitment would be restricted and surplus employees transferred wherever possible to other work within the factory, firm or group; a number of them specified the matters to be taken into account in deciding who was to be dismissed; just over half the companies provided a right of appeal; three-quarters of them promised some form of assistance in getting employees other work (including giving advance notification to the Ministry of Labour staff); many companies offered priorities in re-engagement to former employees; and 67 of the 236 policies provided for the granting of more than one week's notice.

It is perhaps heartening that these companies have taken the step of evolving prescribed policies (though it is staggering that a quarter of them do not provide for consultation with the employees' representatives, and nearly three-quarters do not undertake to give more than one week's notice); but these firms, employing something over 1,100,000 people between them, have only a fraction of the total number of employees in the country. Perhaps the firms who do not have such a policy excuse themselves on the grounds that they are unlikely to be progressive enough to take advantage of technical advance anyway.

Putting Management in Perspective

LAST month the Cambridge University Board of Extra-Mural Studies held their ninth annual residential course for "Managers in Industry" at Madingley Hall. Forty-one members of management, most of them aged between 30 and 40, came from a variety of industries, private and public, and from the civil service and the banks, to take part in a concentrated one month course designed to help to equip them for higher management.

Like the Oxford Business Summer School—which has roughly similar aims, though a slighly different organization and syllabus—the Cambridge course does not set out to teach management in the sense of providing training in the tools and techniques of management. That job is performed effectively by some of the management consultants.

Indeed, in a sense the Madingley Hall course is complementary to these courses on management techniques, for it is intended to stimulate basic thinking about the aims and purposes of management and to put these aims and purposes in perspective against the background of the national economy.

Thus, the people who can gain most from this course are those who have already had experience of the internal problems of management (that is why there is a fairly rigid minimum age limit of thirty) and have reached a position from which promotion over the next five or ten years is likely to involve them with the more general problems of management and with the external relations of their company in the national economy. In the university atmosphere of Madingley Hall practising managers can stand back from the pressure and demands of their day-to-day experience and, with the help and guidance of a highly qualified staff, see their problems in a broader view.

Over-subscribed

The course is invariably over-subscribed—its number is normally limited to 40—and, before making a final selection from the applicants, the Board ask employers to report fully on the candidate's suitability for the course. In particular, it is important that the potential course member should be far enough up the promotional ladder to benefit from the broadening influence of the course, and to make a constructive contribution to it.

This year's course included engineers (the biggest single group, as it happened), accountants, research and development scientists, sales and commercial managers, production and personnel executives, civil servants, two assistant bank managers and a journalist turned administrator. Two course members were already on the boards of their companies and 21 of them were graduates though, it should be stressed, the holding of a degree is not one of the important qualifications looked for by the Extra-Mural Board.

Beneath dreaming towers—Cambridge's, this time—top managers of the future study the problems of top management at Madingley Hall, a university hall of residence.

A few weeks before the course begins each member receives a preparatory reading list of four or five books, chosen mainly to provide a useful corpus of background knowledge but also to break the busy manager into the habit of studying again. On arrival at Madingley Hall, the participating managers are divided into five syndicates (in some years there have been four) and much of the most valuable work of the course is carried out in these groups, each of which includes a wide cross-section of experience and expertise.

Syndicate Responsibilities

At some time during the course, it is likely that the individual course member will have to act as chairman or secretary to his syndicate. He will then have to bring the group to an agreed opinion, draft a written report, and defend that report under analysis by other syndicates and the tutors. This forms an invaluable training in amassing evidence, distinguishing between the important and the unimportant, and presenting a case from a written report. Together with training in committee procedure, these are skills which are particularly important to the man on the threshold of top management.

This year, each syndicate was required to report half-way through the course on "The Chancellor's Dilemma" (an exposition of what should be the Chancellor of the Exchequer's policy and how that policy should be implemented) and again, at the end of the course, on "Britain in Europe" (an examination of the economic consequences for Britain of both membership and non-membershp of the European Economic Community). Each report, of about 2,000 words, was made with detailed reference to books, articles and pamphlets, Government White Papers and other reports, and a variety of basic source material.

In addition to contributing to his syndicate report, each member had also to work on an individual report with reference to similar sources. He was given—as distinct from choosing from—one of the following titles: "Monopoly and Restrictive Practices," "Nationalized Industries, "Newly Developing Economies," "The Business Man, 1760-1960," "Education and Democracy" and "Patronage and the Arts." These, obviously, were all subjects intellectually stimulating for the truly potential top manager.

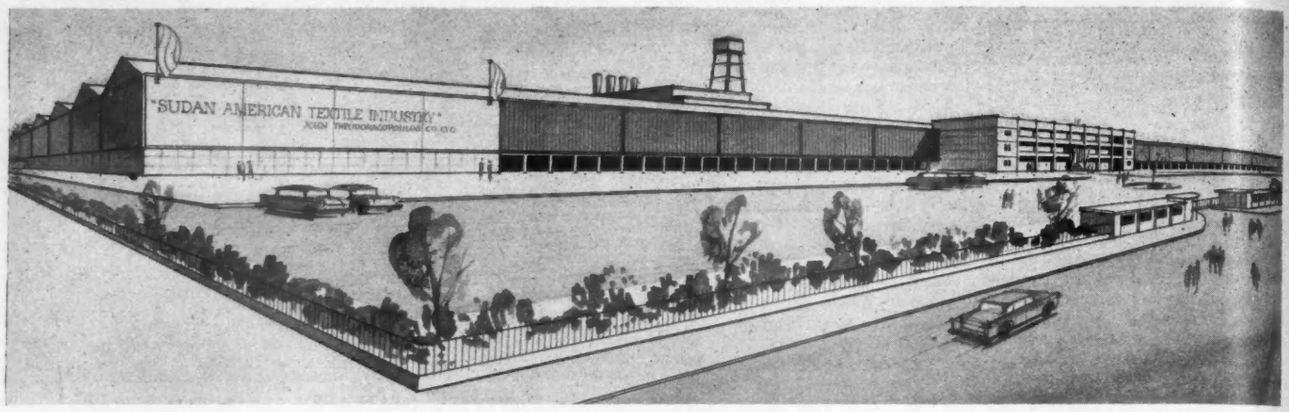
Invigorating Experience

Instruction on the course is by lectures, seminars and close and constant contact with tutors of a quality which could probably not be found outside one of the senior universities. The director of studies and the four resident tutors—all university lecturers or staff tutors with the Board of Extra-Mural Studies—were in constant attendance and specialist lecturers were also brought in from the Board of Trade, the European Coal and Steel Community, Midland Bank Limited, the National Farmers' Union, the Federation of British Industries, the Trade Union Congress, industry, and various universities.

Most course members work tremendously hard and gain much satisfaction from this almost unique opportunity of applying basic thinking to the management function. From conversation with them, it is clear that they find it an invigorating experience to be able to stand outside their jobs for four concentrated weeks and see them in an uninhibited way in the critical but creative atmosphere of academic freedom. It is to maintain this atmosphere that the Board does not report back to client firms on the student-managers.

Over the nine years it has been running, the course has developed an effective syllabus but the Board is constantly adapting it, usually in fairly minor ways, in the light of experience and the suggestions of course members. This year, for example, a "business game" was introduced, using a computer in the university engineering laboratory. Each syndicate, acting as a management team, was able to simulate the running of a business, one of them to a state of bankruptcy.

Although a month is a comparatively short time to spend on a course of this sort—even when the programme is as concentrated as that at Madingley Hall—there is no doubt that the course members themselves feel that it really has been of benefit to them to be able to think and talk objectively about the wider problems they must be able to appreciate during the next stages in their careers. From the number of firms and organizations which subscribe to the course there is no doubt, either, that industry finds a month at Madingley a sound investment.



Building a Textile Mill in Khartoum

The climate of Khartoum makes special demands on the builders and plant suppliers. High temperatures and tropical rain storms both have to be catered for.

By M. S. Forinton, B.A. (Cantab.), A.M.I.C.E.

Marples, Ridgway and Partners, Limited

In 1959, a consortium of three British firms, the English Electric Company Limited (electrical manufacturers), Platt Bros. (Sales) Limited (manufacturers of textile machinery) and Marples, Ridgway and Partners Limited (civil engineering contractors) was formed to supply a complete textile mill worth about £6,000,000 at Khartoum, Republic of Sudan. The client is Mr. John Theodoracopoulos of Sudan American Textile Industry John Theodoracopoulos Company Limited, and the engineers, who will run the factory for some years, are the Piraïki-Patraïki Cotton Manufacturing Company of Athens. The output of the mill will be 75,000,000 yards of cloth per year. An artist's impression of the will is reproduced above.

Khartoum is hot and dry, with the mid-day temperature above 100° F for six months of the year. Extensive air conditioning was therefore needed to create a cooler and more humid atmosphere within the workrooms. Windows would have admitted heat, and few people could have benefited from a view, which in fact is of featureless scrub land, in rooms about 400 ft square. There are, therefore, no windows in the workrooms, and strong illumination is provided by fluorescent lamps.

LAYOUT

A clear working space was wanted, unencumbered by pipes for water, steam and compressed air, by electric cables and other services. So that these service connections may be accessible at all times, the production floor was raised 11 ft above ground level, and the pipes and cables, air conditioning plant, rain water channels, repair shops, canteens, ablutions and other ancillaries accommodated in the space below. Much of this space is not fully utilized, and is unpaved; it could be turned into additional rooms if these are required.

The main building of the textile mill is 1,042 ft long by 394 ft wide, with its main axis running north-south. A railway siding runs along the west side, bringing in the bales of cotton. In the south-west corner of the building is the cotton store with four bays running east-west, each 180 ft long by 32 ft wide by 38 ft high. This store has reinforced concrete external and internal walls so that each bay is isolated with respect of fire, and an automatic sprinkler system is installed. Each bay is capped by a reinforced concrete barrel vault roof, and is equipped with a ½ ton capacity gantry crane which runs from the entrance at the west end to a platform at production floor level at the east end.

The production floor covers the whole of the remaining area of the building. It is a reinforced concrete slab 6 in thick and 380,000 sq. ft in area, carried on beams generally 12 in wide by 18 in deep and spanning about 15 ft between columns. The floor has a granolithic surface ¾ in thick laid integrally with the concrete over most of its area, and has expansion joints at intervals of 60 to 106 ft. The beams are supported by 2,265 columns, generally 12 in square, on individual foundations about 10 ft below ground level. The dimensions of beams and slab panels were largely standard, and Acrow V-form was used for the slab shuttering. As a result, the contractor was able to maintain high rates of construction of the beam and slab floor, reaching over 19,000 sq. ft per week, with a native labour force that was largely unskilled.

PRODUCTION

The production floor of the main building is divided into three major sections, separated by fireproof walls with automatically closing fireproof doors, for opening, carding and spinning, and weaving. All sections are equipped with automatic sprinkler systems discharging on to the floor and the roof. A large amount of dust is extracted from the cotton and settled in a dust chamber which takes up half the space below the production floor in the opening room section.

The carding, drawing, combing, roving and spinning machinery is being supplied by Platt Bros. (Sales) Limited, but spooling and warping machinery is being obtained elsewhere. Six air conditioning centrals, and a locker room and ablutions for the carding and spinning section are accommodated below the production floor in this section.

In the weaving room Joseph Hibbert and Co., Ltd., have made the sizing plant and the 1,680 looms are being supplied by British Northrop Limited. The area under the production floor accommodates four air conditioning centrals, a machine repair shop, spare parts store, kitchen, canteens and a locker room and ablutions for the weaving section.

CONSTRUCTION DETAILS

Apart from the cotton store, the walls of the main building below the production floor are of precast concrete blocks, 16 in long by 9 in high. External walls are 8 in thick, and internal walls 4 in thick. These blocks were manufactured by a simple machine on site, and in the 8 in size contain two cavities. Above the production floor, the external walls are designed for heat insulation. An 11 in brickwork cavity wall with 1 in thick slabs of expanded polystyrene in the cavity is faced with aluminium trough sheeting externally, and rendered internally. Inside walls are of precast concrete blocks generally, but fireproof walls are of 9 in brickwork rendered both sides. All walls are stiffened by reinforced concrete columns at about 15 ft centres, and by horizontal reinforced concrete members at roughly 10 ft intervals in level.

Apart again, from the cotton store, the roof of the main building is aluminium trough sheeting, carried on steel trusses spanning 66 ft at 15 ft centres. These are carried on steel main girders spanning 45 ft between steel stanchions. Along the east and west walls of the building, the steel stanchions and girders are replaced by reinforced concrete columns at 15 ft centres. To conceal the roof trusses, and services running at that level, a false ceiling of Asbestolux panels carried by aluminium T-sections is suspended from the trusses, and a 2 in thickness of mineral wool is laid on this ceiling to provide heat insulation. The supply and erection of the steelwork, aluminium sheeting and false ceiling were subcontracted to A. and J. Main and Company Limited.

The air conditioning system circulates 1,150,000 cu. ft of air per minute throughout the mill. Fresh air is drawn in generally above roof level, and filtered, cooled and humidified in spray chambers below the production floor. It is then blown through main ducts running above the ceiling, and distributed to slotted secondary ducts running across the building at a spacing of 22 ft 6 in below the ceiling. Slots in the floor of the workrooms allow the air to leave the rooms, carrying dust from the cotton machinery down with it on to filters, and this air is then blown to exhaust at roof level. Throughout the weaving room and in the spinning, spooling and warping areas of the spinning room, direct air humidifiers are placed beside the secondary ducts to keep the humidity in these areas at a high level. The water used in the spray chambers of the air conditioning centrals is chilled by a refrigeration plant in a bay of the power house, and an induced draught cooling tower is used to dissipate the heat. This tower is required to cool 165,000 gallons of water per hour from 99° to 88° F.

Lighting is provided by a double row of fluorescent lamps attached to the base of the secondary air conditioning ducts.

A 3 ton monorail electric hoist half-way along the west side of the main building allows material to be put on rail from the spinning room or the weaving room, or received directly into these rooms.

Adjacent to the north-west corner of the main building, a second building known as the dyeing and finishing house, 263 ft long by 185 ft wide

and of similar construction, houses rooms for shearing, singeing and desizing, bleaching, dyeing, finishing and cloth inspection on its production floor. Machinery in the dyeing and finishing house is being supplied by Sir James Farmer Norton and Company Limited. Finished goods will be stored on the ground floor of this building, which is completely paved and also houses three air conditioning centrals. A three-storey reinforced concrete block in the north side of this building contains offices and a laboratory on the top floor, and chemical storage and dye preparation rooms and a workshop on the production floor.

All production is carried on at the same level as in the main building, but the larger machines, namely the J-boxes and the grey and white pits, stand on the ground floor and project through the production floor. The bleaching and dying machinery employs corrosive liquids which include hot caustic soda, hydrogen peroxide and hydrochloric acid, and the bleaching and dyeing rooms are therefore paved with acid-resistant tiles. Drains from this machinery are also chemically resistant. The effluent will be pumped a distance of 2 miles away to waste.

A 3 ton monorail electric hoist is used to transfer goods from the dyeing and finishing house to railway wagons for transport to Port Sudan.

Rainfall in Khartoum is practically confined to July and August, and averages about 7 in per year, but falls of very high intensity are possible. The rain water drains of the mill are designed to cope with a maximum rate of 10 in per hour, limited to 10 minutes duration, and a maximum rainfall in any day of 4 in. In the main building, downpipes from the trough gutters are set in the steel stanchions and feed into manholes connected by pipes to two brick channels running north and south respectively along the longitudinal axis of the building, and out to two open storage tanks of about 286,000 gallon capacity, near the site boundary. Rain water from the dyeing and finishing building is fed into the Northern channel. The flow in each channel at peak intensity of rainfall will be about 15,000 and 19,000 gpm respectively. About 40 per cent of the annual rainfall may be stored.

POWER INSTALLATION

The normal water requirement of the mill is provided by two boreholes, 250 ft deep and penetrating about 150 ft into the Nubian sandstone, and fitted with 6 in submersible electric pumps delivering 550 gpm each.

Electricity for the mill is provided by a power station with five diesel generators, each of 2,200 bhp generating 1,480 kW. A natural draught cooling tower cooling 18,700 gallons of water per hour from 172° F to 88° F serves the diesel engines. Provision has also been made for accepting up to 500 kVA of electric power from the public supply when required. The power house containing this electrical equipment and switchgear also houses waste heat boilers generating up to 15,000 lb of steam per hour at 57 lb per sq. in for the mill processes, an oil-fired boiler and the refrigeration plant. The power house, the main building, the dyeing and finishing building and a 70 ft high water tower are linked together by underground pipe tunnels. English Electric are responsible for the supply of the power station, air conditioning plant, cabling and other services including pipework.

Building construction started with the main building in April 1960, and all buildings are expected to be complete by mid-November, 1961, when production on a limited scale is due to start. Marples, Ridgway and Partners Limited of London, in association with Marples, Ridgway (Sudan) Limited, have carried out the building work. Installation of plant started this summer, and is due to be complete by mid-August 1962, 30 months from the date of the order being placed with the consortium.

Civil Engineering Contractors: Marples, Ridgway and Partners Limited, 2 Lygon Place, Grosvenor Gardens, London SW1.

Electrical Equipment: English Electric Company Limited, Aldwych, London WC2.

Textile Machinery: Platt Bros. (Sales) Limited, Oldham.

Strengthening Kariba Dam

Over the past 18 months efforts have been made to strengthen the rock shoulder at crest level on the southern side of the Kariba dam on the Zambesi River. Seismic investigations have now shown that the treatment has not proved sufficient and it is proposed to excavate the weak rock and replace it with a gravity concrete block that will reach down to the good quality rock.

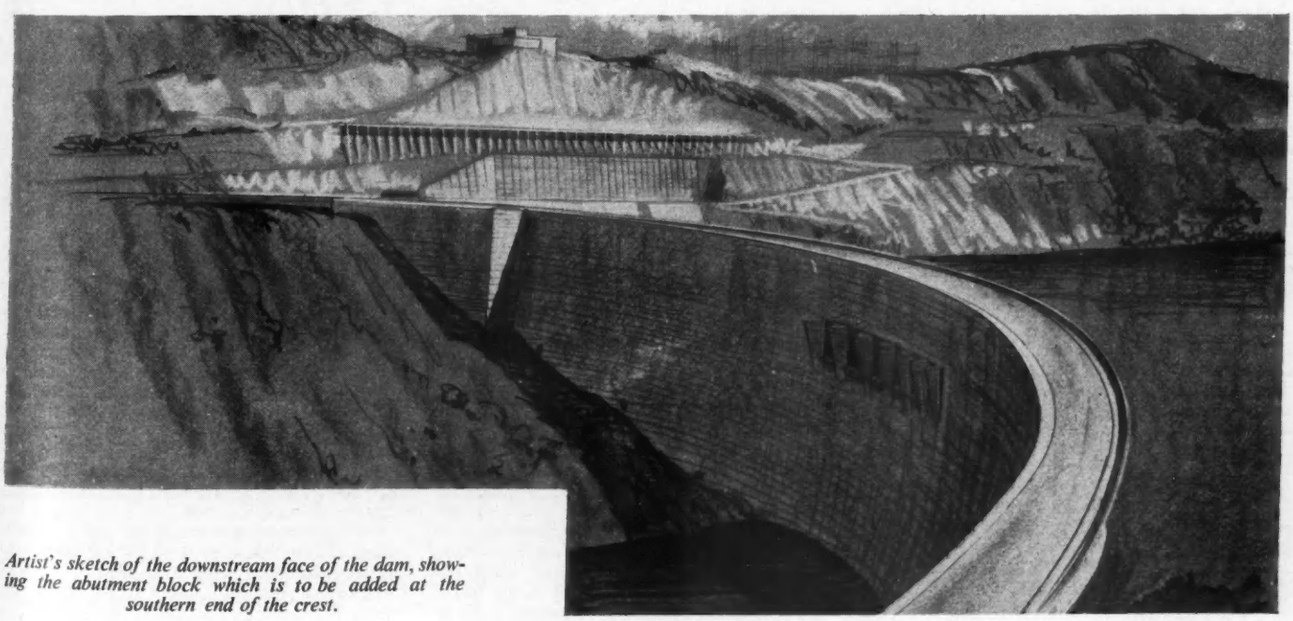
The dam is a double curvature arch which depends for its stability on the flanking hillsides providing sufficient resistance to withstand the thrusts at the ends of the structure. It has always been recognized that rock treatment of a fairly small zone of weak quartzite at this point would be necessary, but in view of the tight construction programme—it was under five years from the commencement of work on the dam to the first of the 100 MW sets being put on load—this work was postponed.

The work of strengthening the quartzite shoulder began soon after the dam wall had been completed and while construction still continued on the underground turbine house, which is located in the sound rock below. Some of the weaker rock—mica schist—was removed and replaced by concrete. Other parts of the rock have been treated by flushing out the very soft material with pressurized water and then grouting. This treatment strengthened the rock mass considerably. But checking by the most advanced seismic methods and other techniques has shown that the south abutment cannot be fully relied upon when the reservoir becomes full and the maximum thrust is developed in the arch. It is expected that two years will elapse before this situation is reached.

The consulting engineers to the Federal Power Board, Gibb, Coyne and Sogei (Kariba), have therefore recommended the construction of the mass concrete abutment to carry the thrust through the quartzite to the sound biotite gneiss. Such abutment blocks are not uncommon for concrete arch dams. The block will comprise about 100,000 cu. yd of concrete as compared with the 1¼ million cu. yd used in the dam itself. An idea of the size of the visible part of the abutment is given by the sketch below, but the greater part will be behind the ground line. Contracts have still to be let for the construction of the block.

During the same period, two of the turbines now operating will be changed from the low level intake to the high level; these temporary low level intakes were built to enable power to be generated at the beginning of 1960 as the first water was impounded.

A full description of the Kariba scheme, including references to the construction of the dam and turbine house, was given in ENGINEERING for 13 May '60, pp. 651-660. The dam was formally inaugurated by Queen Elizabeth the Queen Mother on 17 May, 1961. By 1971, when the scheme is completed by a second power house on the north side, the output from Kariba is expected to be 1,500 MW.



Artist's sketch of the downstream face of the dam, showing the abutment block which is to be added at the southern end of the crest.

To File or Not to File Correspondence

A company can profit by organizing its correspondence files as a source of technical and commercial information.

By H. H. Goom

GKN Group Research Laboratory

CORRESPONDENCE files were described as the "memory" of an organization at a recent conference on business records. Because of the importance of correspondence as a basic source of information on technical, economic and other subjects, Aslib organized this third Conference on Business Records to stimulate interest among those exercising managerial responsibility in the most effective administrative arrangements for the control of correspondence.

What attention does management pay to the administration of correspondence files? In some cases very little. There are managers who imagine that their service is efficient because papers they have asked for at noon are on their desk after their return from lunch. Little do they know of the harassed search that has taken place to find those papers. Probably they seldom stop to think where the papers have come from, where they go to, or where and how they are kept when not in use. Occasionally they may need to authorize the purchase of a new filing cabinet but no further thought is given to the problem. Yet the interest and support of management is vital to the success of any filing scheme.

Do many managers realize the importance of their files as a source of information? In technological and research organizations correspondence can contain as much useful information as documents in the library. The manager, engineer or scientist never works in isolation. His work and his value depend on his contact with others: contact which is maintained by correspondence or by meetings whose outcome may be recorded on paper. The arrangement, filing and indexing of these papers into a useful order, so that any particular line of thought can be retraced from them, constitutes the memory of the organization.

INFORMATION OFFICER'S PART

The effective arrangement and indexing of documents is beyond the capabilities of the filing clerk or office junior who has failed to make the grade as a typist. Junior staff have their place in most departments but their supervision should not be left to equally untrained, but older personnel. A solution to the staffing problem and a possible solution to the problem of providing a useful service was proposed at the Aslib Conference. Mr. W. A. Ashworth, of British Nylon Spinners Limited, suggested that the responsibility for the administration of the filing and correspondence department be placed with the information officer or librarian.

The information officer has been trained to provide information from books, periodicals, reports, pamphlets and a miscellany of other sources and to arrange and index this material to facilitate the speedy retrieval of information. Correspondence is an additional source of information differing only in form from the material found in the library. Library arrangement and indexing techniques need adaptation if applied to correspondence, but the principle of information retrieval is the common factor. Thus the advantages of placing the filing unit under the supervision of the information officer are that the arrangement, classifying and indexing of papers are placed in the hands of one to whom these are well understood techniques; the information officer is given an important additional source of information, and he is made more closely aware of the day-to-day business of his organization.

This proposal presupposes that the correspondence files are centralized to some extent. The pros and cons of centralized and decentralized filing systems have long been argued. Central control is probably the best solution in the small research organization, but this need not imply a strict central geographical location. Central control and decentralized location can be an efficient compromise. The possibilities depend on local conditions but if files are located at the point where they are most used and the actual registration, filing and indexing performed by a central organization then something of the best of both worlds is obtained. The executive requiring instant access to papers is thus satisfied and the principle, that the knowledge and experience recorded in those files are the collective property of the organization and not of some individual, is maintained.

SUBJECT CLASSIFICATION

If the control of correspondence files is placed in the hands of the information officer then the subject classification of files becomes a reasonable proposition. A valid argument against the subject arrangement of correspondence as opposed to alphabetical arrangement by the name of the correspondent has been that satisfactory subject filing involves decision-making beyond the capabilities of the average filing staff. Subject arrangement is admittedly a complex problem but the information officer is trained in classification and employs it in his normal library routine. Subject versus alphabetical filing has long been another of the most debated points in filing practice, and there are some librarians who do not advocate subject arrangement but admit the necessity of adequate subject indexes. Alphabetical arrangement provides a first-class method for straight-forward letter retrieval but subject information retrieval from correspondence is better served by a systematic subject arrangement.

The difference between correspondence and other sources of information is obvious. Correspondence records day-to-day opinions, statements of fact, inquiries, etc., passing to and fro from one organization to another, usually addressed by individuals and sometimes addressed to individuals normally acting on behalf of an organization. A form of continuity develops, any series of letters usually having one main subject theme. This theme should form the basis of subject arrangement but unlike the book or other library material the correspondence file is a growing thing and only when the particular project is completed does the file cease to grow.

Some projects have a very long life and chronological subdivision may be necessary. Additionally the subject of correspondence files can change. This change is usually gradual and the exact point of change is not always perceptible. The original file can, of course, be terminated and a new file started, although this can be difficult if the point of change is ill-defined. The alternative is to re-classify under a broader heading that would cover both old and new subjects.

SPACE PROBLEMS

Whether it be the information officer or the office manager who controls the filing system they will meet the same problems. There are few organizations where space is not at a premium and some policy for the discarding of ephemeral papers must be decided. The waste paper basket has been described as the best piece of filing equipment. Decisions regarding the destruction of documents are best made when the correspondence is received. It is much better to make weeding a continuous process than to confront busy managers every now and then with masses of papers in which they are no longer interested and ask them to decide what needs to be kept. There are various methods of doing this and some organizations mark their correspondence on arrival with a symbol indicating how long it should be retained. This involves more decision making, and here again the information officer is in a good position to determine the long term requirements of his organization and to consign the unwanted material to the waste paper basket where space is cheaper than in conventional filing equipment.

Equipment needs careful consideration. Manufacturers are apt to describe their devices as "filing systems" when in fact they are tools for keeping papers tidy and accessible, excellent for some requirements and unsuitable for others. The introduction of what is termed "lateral filing" in recent years has been a useful space saver over the conventional filing cabinet. In this method the files are suspended as if on shelves and are readily accessible.

In most organizations where individuals from different departments are engaged on the same project some method of circulating files and recording their whereabouts must be devised. If the system is administered by the librarian or information officer then there is the possibility of combining these records with the loan records or at least of adopting a system similar to that employed in the library. This has the advantage that users do not have to become acquainted with two systems, but the true secret of success is to persuade users not to treat library or registry material casually. If the full support of the management is evident then it is easier to persuade users to treat the system with respect.

COMMUNICATIONS AND METHODS

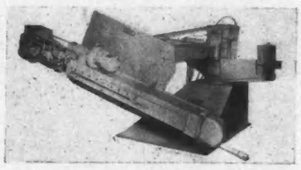
It has been assumed that correspondence is still the main means of communication between organizations and that letters form the bulk of the papers that are placed in the files of an organization. This may not always be the case. The future may well see alternative methods of communication. Facsimile transmission of documents by electronic methods is a possibility but a method of communication which is becoming increasingly popular is the Telex service provided by the Post Office. This method provides a typed message which can at least be dealt with by methods similar to those used with correspondence, but the introduction of subscriber trunk dialling and possibly cheaper trunk calls, will increase the use of the telephone message and reduce the number of letters. This has certain advantages. Letter writing is undoubtedly expensive and any measures which reduce the number of unnecessary papers are to be welcomed. However, it will also introduce new problems as many of these telephone messages may be worth recording. The unrecorded telephone message is often an embarrassment in many organizations.

New methods of storing papers and retrieving information from them are also a possibility in the future. Microfilming has been suggested and used as a means of reducing the bulk of papers stored but the problems of retrieval and the expense involved have deterred the widespread adoption of this method. Mechanical and electronic methods of information retrieval are being investigated for information and library purposes. The problems involved are complex and the equipment expensive but the future may see some developments which will make something of this nature suitable for consideration in filing departments of large organizations.

The problem of records presents a challenge to industry. To keep records is expensive—to destroy records can also be expensive. This is the dilemma and the answer still needs to be found.

BLAST FURNACE DRILL

Automatic Operation



An all electric drill of the rotary type, the Joy BFD model illustrated is reported to offer a number of advantages over conventional equipment for tapping blast furnaces.

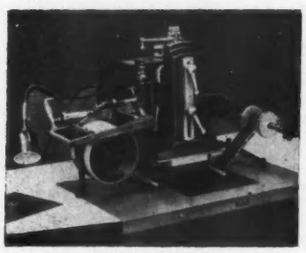
Remotely controlled and push-button operated, this unit requires only one man to drill the iron notch, including penetration of the skull. The operator can be stationed safely in the pulpit area in which the clay gun controls are situated. A steady sweeping motion, without vibration, automatically positions the drill for an accurate tap hole and the powerful rotary action penetrates carbonaceous materials without difficulty. Drill rotation is 300 rpm, and forward drilling speed is 4 ft per minute. Clogging, stalling and lunging through weak areas are avoided and the drill rapidly penetrates the skull. Oxygen lancing is unnecessary and the clay and skull are not damaged or vibrated during drilling. It is claimed that the operator has overriding control at all times, though normally drilling operations are automatic, using limit switches to initiate each phase of the operation.

The drill retracts at 100 to 150 ft per minute, preventing damage to rod or bit, and automatically swings away from the drilling position. Air at 80 lb per sq. in is directed through the hollow drill rod and cleans cuttings from the hole, cooling the drill bit and holding back metal flow. Sparks blown back from the tap hole indicate when to retract.

Individual electric motors operate drill swing, drill rotation, forward motion and retraction. Each motor is readily accessible and is fitted with external grease leads for quick maintenance. Feed lengths are from 6 to 12 ft. Electrical supply between 220 and 240 V, at 3-phase, 25 to 60 c/s, can be used. The complete drill, with base, weighs approximately 15 cwt. *Joy-Sullivan Limited, 7 Harley Street, London W1.*

PLASTICS GOLD BLOCKING MACHINE

Automatic Cycling



Reported to be the first high frequency plastics gold blocking machine with fully automatic cycling, this Acme unit is designed to carry out either cold or hot blocking.

The absence of a heater has eliminated the need for thermometers and thermostats and their associated replacement costs, and a mains filter has not been necessary in the design.

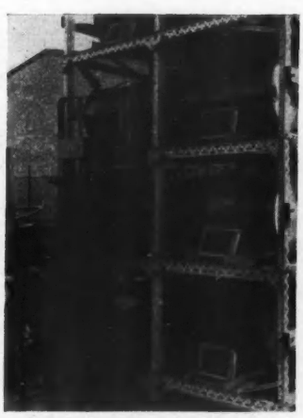
The unit is intended to handle gold and other coloured foils, and has been produced as a complete entity that can be readily fitted to or removed from any standard Acme table model plastics welding machine. Only one operation is required for a particular impression since the single operation irons out the emboss on the base pvc and deposits the metal or coloured foil as and where required. Exceptionally large areas of foil may be utilized—up to 30 sq. in when occasion arises.

Automatic cycling of the foil leaves the operator's hands free for other work, and on suitable applications the manufacturers claim that at least 20 impressions per minute may be expected. Operation of the cycling is by compressed air, for which the requirements are either a small compressor or an existing air supply of 14 cu. ft per hour at a maximum of 80 lb per sq. in.

If the material being handled requires a "hot" embossing the same unit carries out the operation without modification, the only additional requirement here being the normal fitting of a standard Acme heater unit to the press head at the time of setting up the tool. *H.F. Industrial Services Limited, 317-319 High Road, Wood Green, London N22.*

DRUM RACK

With Arrester Gate



This drum rack has been designed for storing metal drums in bulk, and incorporates several new features for improved efficiency.

It consists of an on-the-roll storage installation constructed in Dexion slotted angle, claimed to offer advantages of space saving, easier handling, and simpler stock rotation and control in the sense of "first in—first out."

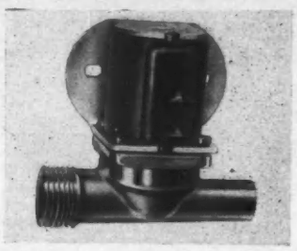
The key to the method used is an arrester gate which cushions the impact of the rolling drum, so reducing damage to it and shock to the framework of the rack. The manufacturers have found that timber runners guide drums more effectively and cause considerably less damage than metal runners.

The arrester gate is operated by an automatic lever device, and though the stop bar stands 8 in high when arresting the drum, it drops to 1 in when the drum is lifted for removal. It is stated that, with 500 lb drums, this racking can safely take up to 14 drums per level; the arrester gate is so designed that one or two drums can be removed at a time by a fork-lift truck.

Racks of various capacities and for drums of different types and sizes are available. *Dexion Limited, Overseas Division, Beresford Avenue, Wembley, Middlesex, England.*

SOLENOID VALVE

For Domestic Appliances



Illustrated here is the Sumlite solenoid valve, which has been designed for the electro-control and water valve gear requirements of a wide range of domestic appliances, such as washing machines and dishwashers.

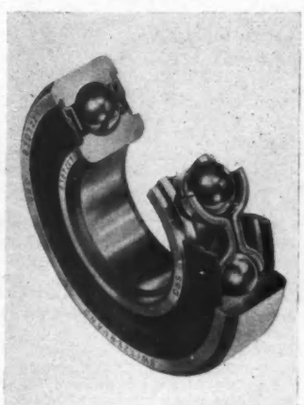
For maximum reliability, even when submerged in water, the valve coil is layer-wound with insulation between each layer of wire, and the whole coil unit is encapsulated in pvc. The unit is tested to hold 300 lb per sq. in line pressure and can operate at an out-of-balance pressure of 150 lb per sq. in; it is stated that it will operate at this pressure even when subjected to a voltage drop.

In operation, the valve makes use of line pressure to do most of the work of opening and closing. The solenoid directly controls only a small pilot valve which in turn operates the main valve. The standard unit is supplied for mounting with a coil in the vertical plane, but valves can be supplied for mounting in any other position if required. No stuffing boxes, glands or pistons are used which may be the cause of sluggish operation.

The coil is fitted with insulated leads or terminal plates for quick connection. The inlet port is fitted with a 60 mesh brass wire gauze filter. The valve body is of brass and all internal parts are of non-corrosive stainless steel. External brackets are heavily plated for corrosion protection. The valve can also be supplied with a built-in flow regulator which can be works-set to give pre-determined flow rates against usual pressure. *Sumlite Controls Limited, The Airport, Pendeford, Wolverhampton, Staffordshire.*

RUBBER SEALED BEARINGS

Designed for Long Life



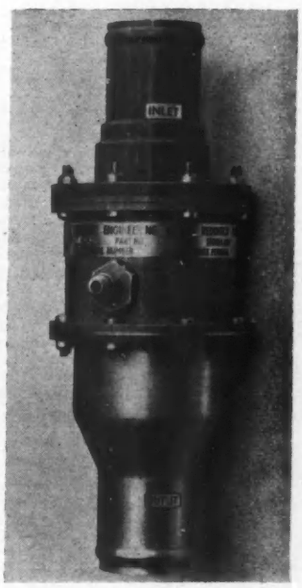
The new type of synthetic rubber sealed, deep-groove bearing illustrated in section here has been developed to overcome the disadvantages which have arisen in the past with this sealing material.

The good sealing properties of synthetic rubber in bearing applications have sometimes been offset by the flexibility of the material allowing the seal to come into contact with the cage, thus imposing limitations on operating speed and load. In these new bearings, developed by SRO Ball Bearing Works J. Schmid-Roost Limited of Zurich-Oerlikon, Switzerland, the seal is located in the outer race and makes rubbing contact with the inner race. Where rigidity is required in the seal it is backed by a metal section, but the light rubbing contact with the inner race is not impaired.

Where the bearing is sealed on both sides it can be supplied lubricated for life with a grease which is effective over a temperature range of 22° F to 235° F. These bearings are currently available in certain sizes of the 6,000, 6,200 and 6,300 series and are denoted by the suffixes z1 and zz1 for those sealed one side and those sealed both sides respectively. *SRO Bearing Company (Sales) Limited, 164 Camberwell Road, London SE5.*

VENT VALVE

For Aircraft Fuel Systems



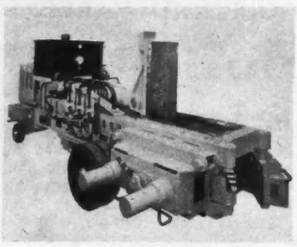
A new dual inward/outward vent valve, the R.V.63, has been developed for use in the pressure control of tanks in aircraft fuel systems.

The inward venting is controlled by a lightly spring-loaded diaphragm and normally operates during a dive to maintain positive pressure. Constructed coaxially, the outward relief valve is spring-loaded and either operates during climbing or relieves excess pressure due to temperature variations on the ground. For ground refuelling, this valve is held in the fully-open position by a piston which overrides the spring-loading and is operated by pressure in the refuelling lines.

During inward venting the valve passes 20 cfm with a pressure drop of 0·3 lb per sq. in at ground level. The outward vent has a nominal flow-off pressure of 3 lb per sq. in and a 6 cfm air flow at 3·4 lb per sq. in back pressure. Weight is 1¼ lb; 1½ in beaded connections are fitted. *Hymatic Engineering Company Limited, Redditch, Worcestershire.*

SCRAP METAL BALING PRESS

Mobile



THIS 100 ton mobile three-way pressing scrap-metal baling press is designed to produce a bale suitable in size and weight for the requirements of modern furnaces.

The machine is reported to be capable of producing 1 cu. ft bales at a rate between 20 and 30 an hour (each weighing 120 to 140 lb), according to the type of material and labour available for loading. The press is powered by a 35 hp electric motor or a 40 hp diesel engine, or with both types of drive if required.

The unit is mounted on solid rubber tyres, with a tow-bar fitted to the front bogie; maximum tow speed is 2 mph. Specially hardened reversible steel shear blades are fitted. The box and lid are lined with wear-resisting replaceable liner plates. The baler weighs 15 tons, is about 20 ft in length and 8 ft in overall width. Height with trampler raised is 8 ft and working height of the box is 3 ft 10 in.

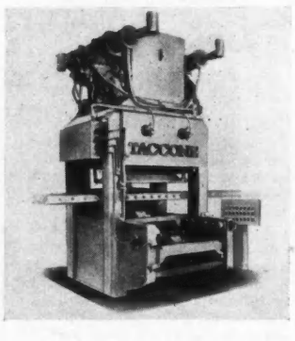
The box measures 50 by 24 by 24 in and holds some 150 lb of mixed steel scrap.

In operation, with the door locked by positive cam action and the box filled with scrap metal, the trampling lid is closed, shearing all overhanging scrap and reducing the charge to 50 by 24 by 12 in.

The side cylinders then reduce the charge still further to 50 by 12 by 12 in. The main ram is then brought forward to exert a maximum load of 100 tons on the 12 by 12 in area of the bale. Finally, the door is opened and the main ram brought forward a further distance to eject the bale. *Fawcett Preston and Company, Bromborough, Cheshire.*

MOULDING MACHINE

High Density



NOW available in the United Kingdom, the Taccone hydra-pneumatic high density moulding machine is claimed to represent a basic advance in foundry moulding technique.

The machine is of interest in the bath and sanitary ware and autocasting industries; it enables high density green sand moulds to be produced with a wide range of green sand mixes. A uniform hardness of up to 100 (Dietert) can be obtained using a combination of the Taccone slack diaphragm technique and hydraulic power.

The diaphragm is replaced by a multi-layer compensating pad which is expanded by normal line air pressure immediately prior to the upstroke of the cylinder. The air trapped behind the compensating pad (depending on the initial air pressure and the force supplied by the ram) can exceed 450 lb per sq. in. At this pressure the maximum hardness can be obtained. The combination of the expansion of the compensating pad and the upward stroke of the hydraulic cylinder maintains the sand in motion and this fluid action enables the sand to fill completely any pocket or crevice, thus giving a uniform density.

All hydraulic units of the machine have been kept clear of the mould area to eliminate oil contamination of the moulding sand. A fire-resistant fluid is used in the hydraulic circuits. Speeds of up to 300 moulds per hour can be attained. *Baker Perkins Limited, Foundry Department, Bedewell Division, Hebburn-on-Tyne, Co. Durham.*

SOUND LEVEL INDICATOR

Small Size

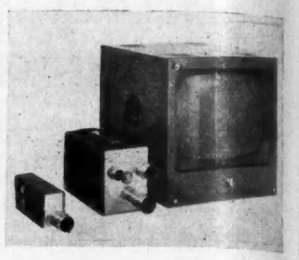
THE Type 1408D sound level indicator has been designed to meet the need for a simple and compact lower-cost instrument for less exacting applications.

This completely transistorized instrument uses a high sensitivity Rochelle-salt crystal microphone which feeds into a special high input impedance circuit, this being followed by a four position attenuator and buffer stage. The output from this section is applied to a two-stage amplifier with associated resistance-capacitance weighting networks, designed to conform with the proposed IEC specification for sound level meters. These networks feed into the meter amplifier circuit.

Both amplifier sections have been designed to have very stable gains which are virtually unaffected by transistor parameter variations or supply voltage. Battery life is given as about 80 hours. Sound level range is put at 64 to 110 dB above the standard sound pressure level of 0·0002 dyn/cm.^{2} Calibration is from −6 dB to +10 dB; dimensions are 6 by 3 by 2¼ in and weight is about 14 oz with battery. *Dawe Instruments Limited, Harlequin Avenue, Great West Road, Brentford, Middlesex.*

TV DOCUMENT TRANSMITTER

Low-Cost System



THE development of a new ultra-sensitive vidicon TV camera by the American Microwave and Television Corporation is now reported to make possible the installation of low-cost systems for document transmission.

Complete pages of print, in typewriter size or smaller, can be instantaneously transmitted and read with ease, it is claimed. The Vicon V-945 television system employs 945 line scanning which resolves 650 lines in the vertical direction. A very small scanning spot in the camera, together with wide band (18 megacycles) electronics, is capable of resolving 700 lines in the horizontal direction, which represents an unusually fine degree of resolution.

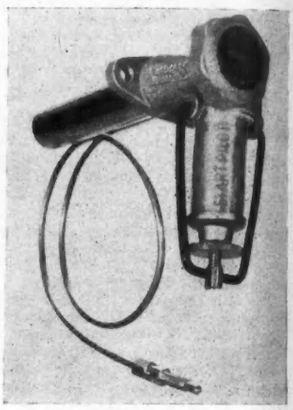
Any number of V-945 systems may be used together in synchronous operation. Only one system need be equipped with sync signal modules, and any number of monitors may be operated from the system at distances of up to 1,000 ft without amplifier units.

This new closed-circuit TV system uses either cable or microwave. The high sensitivity and low picture noise attributed to the camera are due to the elimination of artificial high frequency compensation circuits. A dc Zener regulated filament supply in the camera is also designed to eliminate problems which may arise due to cable length variations. The video amplifiers are flat to 15 mc with roll-off to 20 mc.

Applications for the new system are foreseen in such institutions as banks, hospitals, medical clinics, security brokerage firms, school systems, universities and government departments as well as in industry. *Ad. Auriema-Europe, S.A., 172A Rue Brogniez, Brussels 7, Belgium.*

SMALL DIESEL STARTING AID

For Cold Climates



KNOWN as Unit No. 6, this device is a cheaper and greatly simplified version of the Start Pilot equipment which is already in use for instant starting of diesel engines in cold climatic conditions.

This unit has been designed for use with small capacity engines and costs approximately one-third of the price of the parent model. It uses the same 18 cc capsule of starting fluid which is already widely available.

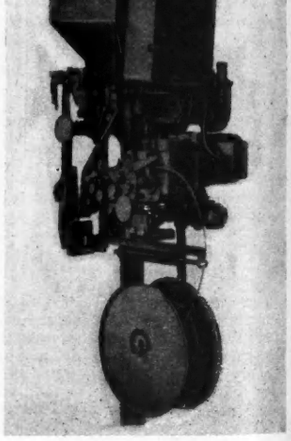
In use this capsule is attached to the pump body and is then punctured by a built-in piercer. Subsequently, operation of the single-acting air pump serves to pressurize the capsule, thereby atomizing the fluid and discharging it through tubing and a nozzle into the engine intake air stream.

On a series of different engines of up to approximately 5 litres capacity, satisfactory starts are stated to have been made down to a temperature of − 25° F, while a single capsule has provided four daily starts at − 15° F in the case of an engine with rated capacity of 2 litres.

It is claimed in the light of such tests that this new model will be fully adequate for the large majority of diesel engines whcih are intended for operation in the commercial cold areas of the world. *Start Pilot Limited, 27 Ashley Place, London SW1.*

AUTOMATIC VERTICAL WELDER

Remote Control



SHOWN here is the A-433-M automatic welder, which was represented at the USSR Industrial Exhibition this year at Earls Court, London (7 to 29 July).

This unit is designed for vertical single-pass electro-slag or submerged-arc welding with positive forming of longitudinal weld seams on the butt-joined parts. The system comprises a self-propelled welding unit and a control cabinet. The carriage mounts a welding head with cable, an electrode wire reel, a flux hopper and a control desk. The carriage and wire feed are driven by separate electric motors. A constant rate of electrode wire feed is given through change gears.

The welder travels along a lightweight tooth-racked railway, which may be rigid, for straight welds, or flexible, for curved welds, and which is set parallel to the weld seam with a template. Thickness of metal to be welded is from 10 to 50 mm, and welding speed is 2·6 to 21 m per hr. *V/O Machinoexport, Moscow G-200.*

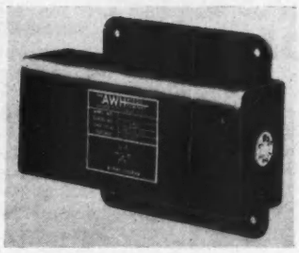
ELECTRONIC TIMER

Limitless Delay

DESIGNATED as the 31800 Series Precision Electronic Time Delay Relay, this unit, for which an accuracy of 0·01 per cent and a time delay range of 50 milliseconds to infinity are claimed, has just been announced from the USA.

For operation over a temperature range from −54° C to +71° C, this hermetically sealed timer is rated at 30*g* for shock and 500 c/s at 10*g* for vibration. Standard versions are constructed for 50,000 ft altitude, but it is stated that higher altitude requirements can be satisfied if necessary. The relay has contact arrangements from single-pole single-throw to four-pole double-throw, while the contact rating at 28 V dc or 115 V ac can be 10 amperes resistive, 5 amperes inductive; or 5 amperes resistive, 3 amperes inductive; or 2 amperes resistive, 1 ampere inductive.

Life is estimated at 100,000 operations at the rated contact load, while reset time can be only 25 milliseconds. Input voltage is 24-30 V dc, while power required is 5·75 W maximum. Other



dc or ac voltage ranges are available. Current requirement is 200 milliamperes maximum.

This unit utilizes crystal-controlled binary count-down circuits for either single or multiple delays, and it employs aged components for stability.

Standard versions are energized to time, and de-energized to reset. Reverse acting versions are pulsed to start, and automatically reset, while make-ready versions are energized to make ready, de-energized to time, and pulsed to reset. Versions with adjustment by external or internal potentiometer or internal switch are available. *A. W. Haydon Company, Culver City, California.*

DUST METER

Continuous Measurement

KNOWN as the Konitest dust meter, this instrument is designed for the accurate indication and recording of minute quantities of small dust particles.

It will be of value for the continuous measurement of dust in air or gas in many industries and laboratories, and of use to smoke inspectors. The apparatus is simple and is stated to require very little maintenance and attention. The Mark 1 version shown here is for applications when suitable suction is already available and no separate fan is necessary. The Mark 2 model is suitable for the measurement of the dust burden in boiler exit gases and other industrial gases of high temperature; a Mark 3 version measures dust in industrial gases at ambient temperature.

The principle of operation is based on the fact that when a dust particle rubs against a surface it will take a static charge, while the surface against which it rubs will take an equal but opposite charge. If therefore dust particles carried in an air or gas stream are brought

in contact with an insulated surface connected to earth through a galvanometer or an amplifier with a milliammeter, the latter will show a current which will vary in relation to the amount of dust.

The quantity of dust in suspension in a gas or air stream is shown instantaneously by the instrument, and a warning device can be operated if desired. *James Gordon and Company Limited, Dalston Gardens, Stanmore, Middlesex.*

DIAL ASSEMBLY

Panel-Mounting

USED for the angular positioning of servo-mounted devices, the dial assembly Model DA illustrated here can be mounted on any panel.

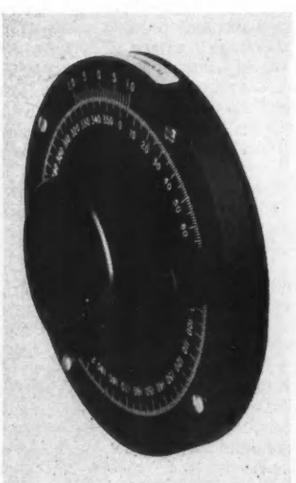
These units are intended for use in the ground support consoles of many missile systems, where qualities of appearance are also of importance.

The rear of the dial contains a mounting hole and a spring-loaded collet which permits the component to be inserted with ease.

A coaxial hole through the assembly enables zeroing of the synchro or pot relative to dial indication. Precision-machined aluminium parts are used, designed to withstand the demands of field operations.

Range is 0° to 360° continuous, and accuracy is quoted at 0·1° with readability at the same level.

The outside diameter is 5 in; Vernier knob ratio is 10 : 1 and coarse knob ratio 1 : 1. With the alternative model DR, recommended when a high degree of setting is required, 1,440 turns of



the small knob rotate the shaft through 360°. *Theta Instrument Corporation, 520 Victor Street, Saddle Brook, New Jersey, USA.*

GEAR ANALYSER

Inertia Type

THE new Red Ring rolling fixture type of gear analyser shown here utilizes inertia principles and electrical indicators to provide three simultaneous precision measurements of gear tooth accuracy. It has been developed by National Broach and Machine Company, 5600 St. Jean Avenue, Detroit 13, Michigan, and it is said to be capable of detecting nicks on tooth profiles as small as 0·0005 in high.

The unit has a pivoted motorized master gear that is meshed with the gear to be inspected. Centre distance movements of the master gear are detected by three electrical indicators to provide separate measurements of work gear tooth eccentricity, tooth-to-tooth variation and tooth oversize and undersize conditions. Measurements of the electrical indicators are transmitted to a panel unit where lights indicate rejects and their causes.

By virtue of separate tooth-to-tooth and eccentricity measurements, a small nick in a tooth profile can indicate a reject gear while the gear is being passed

for a larger eccentricity tolerance. The indicator unit for the separate tooth-to-tooth measurement uses an unusual inertia-controlled motion, where the indicator only reads the high point of indication instead of following the entire in-and-out motion.

The gear rolling fixture has a 22½ by 15 in cast iron base, and a universal motor driving the pivoted master gear shaft with a timing belt. The fixture's electric indicators have repeat accuracies of less than one ten-thousandth of an inch, and its centre distance capacity is from 1¾ to 12⅛ in. *Precision Gear Machines and Tools Limited, Bodmin Road, Wyken, Coventry.*

MAGNETOMETER

Educational Use

THIS instrument, the "Varicoil" magnetometer, has been produced for use in advanced physics instruction in schools and technical colleges.

An improved version of tangent galvanometer, it enables the relationship between Field and all three variables in the reduction factor to be established, where the conventional galvanometer allows only the F : i relationship. It also demonstrates that, for a given current, the field at the centre of a circular coil is inversely proportional to its radius or is directly proportional to the number of turns.

The instrument consists of a 12 in by 12 in board with five concentric turns of different radii in a printed circuit, with a deflection magnetometer at the centre. A tapped, wire-wound circular coil concentric with the others and in the same plane has one side exposed for ready measurement of its mean diameter. It has 15 turns and is tapped at 1, 3 and 7 turns so that, by a selection of terminals, a wide range of turn values may be

obtained. The 7 in diameter plastic base carries a series of terminal sockets labelled to correspond with the single turns and the tapped coil respectively. The leads are of twin flex, to minimize magnetic disturbance. *Griffin and George Limited, Ealing Road, Alperton, Wembley, Middlesex.*

LOW TENSION CELL

For Stand-by Duties

DESIGNED to cover a wide field of duties, this 2-volt cell, type DTP, is particularly suitable for intermittent and stand-by requirements, as in burglar and fire alarms and clock systems, and other applications where maintenance is under floating or trickle-charge conditions.

The cell consists of one positive and one negative mass-type plate, assembled in a white polystyrene container with ribs moulded in the bottom to hold the plates in position without separators. The black polystyrene lid is permanently cemented to the container and the polystyrene vent plug fits flush with the top of the lid. The terminal assembly comprises nickel-plated brass screws with coin slots for easy manipulation.

Capacity at the 1,000 hour rate is given as 20 Ah, at the 100 hour rate 12 Ah and at the 20 hour rate 7 Ah. The cell measures 2⅛ in long by 2¾ in wide by 5½ in high, and weighs 2 lb 3 oz filled and charged. *Chloride Batteries Limited, Exide Works, Clifton Junction, Manchester.*

Call for Cooperation

PROJECTS encouraged by Euratom usually involve a large financial outlay among countries that have only a limited budget for nuclear affairs. It is imperative therefore to eliminate any unnecessary reduplication of work. The establishment of an efficient liaison committee, which is able to have an up to date picture of all the projects that may be spread out over a wide distance at various laboratories on a certain aspect of the industry, is one way of overcoming this and should be encouraged on a far wider scale. Euratom has several committees for this work and the recent birth of a documentation centre for pooling information is another beneficial move to make published material available to as many authorities as possible.

Extension to Marine Projects

The Euratom Commission is to participate in three new research and development projects for nuclear marine propulsion:

A project undertaken by the Italian CNEN, Fiat-Ansaldo Group to make a complete draft for a reactor powered tanker. The project is scheduled to last two years and Euratom will contribute up to $1·2 million.

A three year programme with the Netherlands Reactor Centre (RCN) to investigate the pressurized water reactor system with the aim of preparing a complete design for a marine reactor of this type. Euratom will contribute up to $1·9 million.

A five year general research programme with the GKSS in Hamburg to which Euratom will contribute $1·8 million to make experiments of fundamental importance in nuclear marine propulsion, for example, shielding and vibration tests.

Euratom will be responsible for the co-ordinating of the research work carried out under all its projects and a special liaison committee has been formed.

Euratom's Fourth Research Centre

Euratom has now obtained its fourth research centre when the Dutch centre at Petten was transferred at the end of last month. The other three centres belonging to Euratom are Mol in Belgium, Ispra in Italy and Karlsruhe in Germany. A high flux reactor is being built at Petten and is due to go critical towards the end of the current year.

Two New Director Generals

Dr. Arne Signard Eklund of Sweden has been appointed by the Board of Governors of the International Atomic Energy Agency to the post of the Agency's Director General. Dr. Eklund is a nuclear physicist and a reactor expert and will take over the post from Mr. Stirling Cole after the expiration of his four year term of office on 30 November, 1961, subject to the approval of the General Conference. Dr. Eklund acted as Secretary General to the second United Nations Geneva Conference on the Peaceful Uses of Atomic Energy in 1958, and is chairman of the International Board of Management for the OEEC Dragon Project at Winfrith Heath.

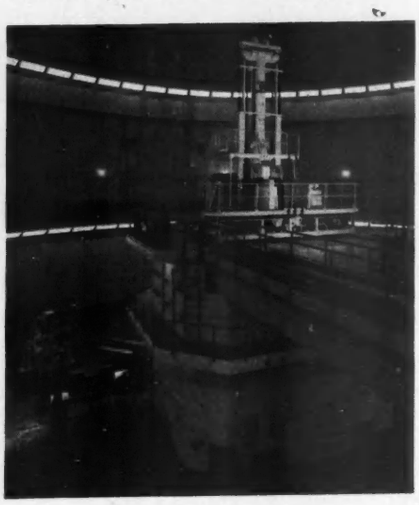
Professor Victor F. Weisskopf, who joined CERN in September last year as a member of the directorate responsible for research, became the fourth Director General of the organization on 1 August, 1961. He is succeeding Dr. J. B. Adams who returns to the Culham Laboratory as director of the Controlled Thermonuclear Establishment.

New Guide to Nuclear Energy Courses

A new edition of the *Catalogue of Courses on Nuclear Energy in OEEC Countries* has been published by the European Nuclear Energy Agency for the academic year 1961-62. It contains a list of the establishments where courses relevant to nuclear energy are given; syllabuses of the main courses on nuclear physics, chemistry and engineering and further course details; and information on the principal items of nuclear physics and engineering equipment available. Copies of the catalogue can be obtained from OEEC European Nuclear Energy Agency, 38 Boulevard Suchet, Paris 16.

Nuclear Tankers

Nuclear power for tankers has evolved along three lines: the development of the pressurised-water reactor by Nuclear Combustion; the development of the boiling-water reactor using the indirect cycle by Westinghouse Corporation; and the direct boiling-water system by General Electric Company. With the aim of increasing the power density and using low-enriched fuels the technical evolution of these systems has converged. The direct-cycle BWR has permitted a further reduction in power generating costs through the elimination of system components. Boiling within the reactor core has eliminated the recirculation pumps since natural circulation is used. This development presents a major unresolved problem in the direct-cycle BWR



The FR 2 research reactor at Karlsruhe showing the fuel charging machine and on the left the horizontal experimental flask.

arising from the effect of ship's motion. Acceleration forces will cause variations in the natural convectional flow, which may produce voids and hence variations of the neutron flux and power level. These changes may also provide feedback causing further changes in the coolant flow rate. Design studies have allowed for 0·3*g* for heavy accelerations and 0·7*g* for pitch at the extremities of the ship. All three designs have negative void and temperature coefficients throughout the entire temperature range. The PWR which operates with almost negligible voids is capable of following all feasible load changes without the need for steam dumping. The direct-cycle BWR must use the control rods with load changes, and also dump steam to the condenser in the event of a turbine "trip-out" in order to avoid an abnormal power rise due to collapsing of the steam bubbles as the pressure builds up. In the cost evaluation the percentage by which nuclear exceeds conventional systems is 35·2 per cent for the BWR direct cycle, 47 per cent for the indirect cycle and 29 per cent for the PWR. All three designs were taken for a plant providing 30,000 maximum shaft horse-power. ("Three Design Studies for Selecting a Prototype Reactor for a Nuclear Tanker," TID-8528, compiled by the USAEC and the Maritime Administration.)

Nuclear Electronics

350 scientists from 28 countries attended the conference on nuclear electronics in Belgrade recently organized by the International Atomic Energy Agency.

A novel device for personnel radiation monitoring was described by C. J. Borkowski of the Oak Ridge National Laboratory. The instrument weighs 3½ oz and is the same size as an ordinary fountain pen. It is worn in the pocket of the user and provides immediate audible and visual indication of the radiation dose rate; the flashing rate of the neon lamp and the pitch of a warning tone increase in proportion to the dose rate. To ensure continuous protection there is no "on" and "off" switch: the instrument operates for one month using a four volt mercury battery system.

Three scientists from Yugoslavia described an instrument for distant radiation control. The instrument is connected to a normal telephone apparatus and gives information of the radiation level in a particular area without requiring a technical person present.

Spark counters and semi-conductor detectors gave rise to keen interest. The former are based on the count of electrical sparks produced by ionisation and the latter either on the ionization or damage in solids.

1962 Budget for the IAEA

The 1962 budget of the International Atomic Energy Agency provides for a total expenditure of $8,316,000, which represents an increase of 4·4 per cent over the total amount budgeted for the current year. The main feature of the budget is an increase in allocations for the Agency's substantive activities such as technical assistance, training, the organization of scientific meetings, and scientific and technical services to Member States. The budget is divided into two parts: the regular budget, which is financed from assessed contributions of Member States; and the operational budget, which comes from the Agency's General Fund and is made up of voluntary contributions. Some of the main allocations include: $885,000 for scientific and technical services and laboratory charges, $260,000 for the distribution of scientific and technical information, $827,000 for fellowships and training, and $785,000 for technical assistance. It is also proposed to set aside $40,000 for the operation of the Agency's two mobile radioisotope laboratories.

Reactor Notes

Kansas University: Construction has begun at Kansas University on a 10 kW pool-type reactor moderated by light water and employing natural convection for coding and highly enriched uranium fuel.

Rocket Project: Aerojet General Corporation and Westinghouse Electric Corporation have been selected to undertake the first phase contract for the development of the NERVA project (Nuclear Engine of Rocket Vehicle Application). NERVA is part of the project ROVER and it will be used as a prototype for reactors under development at the Los Alamos Scientific Laboratory.

Grant to China: The United States Atomic Energy Commission has presented $350,000 to the Government of the Republic of China towards the cost of the completed research and training reactor project at the National Tsing Hua University. China is the ninth country to receive a grant from the USAEC for a completed research reactor project. The reactor is a 1 MW(t) heterogeneous light water cooled and moderated pool type reactor, designed and built by International General Electric in cooperation with Chinese scientists and engineers. The fuel elements are fabricated from 20 per cent enriched uranium leased from the United States. The project will provide a training centre for students and technicians, and increased emphasis will be placed on research, with a small radioisotope production.

Companies

Pattern of Things to Come?

COMPAGNIE FRANÇAISE DES PETROLES, the giant French oil company, is an example of the endeavours which some continental concerns are now making to extend their business interests in this country.

Their British subsidiary, TOTAL OIL PRODUCTS (GB) LIMITED, Wigmore Street, London W1, are expanding rapidly and expect to open no fewer than one hundred service stations by the end of their first year in the retail petrol market. Total are the lessees of the car park, service station and shopping centre at the Lee Circle development in the heart of the city of Leicester. The petrol forecourt there covers an area of 16,500 sq. ft and has one of the largest installations of pumps in Great Britain, enabling 14 vehicles to be fuelled at the same time.

To a large extent, the high-speed car washing, polishing, lubricating and servicing which will be available at the Lee Circle development are the outcome of forward thinking by Total's directors and executives, who were quick to appreciate the need for these facilities and their business potential.

Independently of each other, Total, MULTIDEK CAR PARK DEVELOPMENTS LIMITED, and AUTO-MAGIC FIVE MINUTE CAR WASH (DISTRIBUTORS) LIMITED have been developing new ideas and standards of service to benefit the motoring community and it is significant that these have all been brought together at Leicester.

Keen Competition from Overseas

As is well known, the DISTILLERS COMPANY LIMITED have many interests outside their production of whisky and gin.

There was a satisfactory increase in the volume of turnover of the company's Industrial Group, particularly in the realm of chemicals and plastics during the year ended 31 March, 1961. In the latter part of the year, however, this progress was largely offset by lower selling prices, which led to reduced profit margins.

Competition was vigorous and was much aggravated by the large increase in dumping. Oversea producers enjoying heavily protected domestic markets took advantage of their circumstances to export their marginal production at low prices. It was not only the chemical and plastics industries which suffered, of course, for a comparable situation existed in a large range of industries.

Sir Graham Hayman, the company's chairman, in a recent comment on the position, stated that, in view of the deterioration in the national balance of payments, it was noteworthy that criticisms which had been directed at the competitive ability of British industry had largely failed to emphasize this extremely important factor. It was a factor which adversely affected not only the home market but also firms' ability to export.

It was clear, Sir Graham felt, that strong competitive influences would continue to prevail, at least for some time. In spite of this trend, however, there was a substantial growth potential in the chemical and plastics industries and the Distillers Company expected to share in the expansion of demand that might be foreseen with reasonable confidence.

New Water Soluble Resins

In the company's plastics division, there have been increased sales of British Resin Products and polyester resins, in particular, have been well received for reinforced plastics applications.

New water soluble resins, developed at the company's research laboratories at Barry created widespread interest, not only among paint manufacturers, but in a number of industries using paint. Good progress continues to be made in the sale of Rigidex, the low-pressure polyethylene produced by BRITISH HYDROCARBON CHEMICALS LIMITED.

In addition to being manufacturers of chemicals and plastics raw materials, the BRITISH XYLONITE COMPANY LIMITED had acquired an exceptional background of experience in the conversion of plastics into rod, tube, sheet, film and monofilaments, as well as in the fabrication of a wide variety of industrial articles and consumer goods. The amalgamation of those operations with the existing activities of the Distillers Company in the chemical and plastics fields should produce worthwhile economies and benefit both companies in the pooling of research and engineering facilities.

In this connection, the Distillers Company have installed additional laboratory and library facilities at their central research department at Epsom. Their total budget for research during the year ended 31 March last amounted to nearly £2½ million.

Serving the Brewers

Among other users, brewers are increasingly employing carbon dioxide in the storage and movement of beer. There is, in fact, a growing demand for this chemical both for industrial uses and in the food and beverage trades.

The carbon dioxide capacity of the Distillers Company was substantially increased during the year under review and their sales reached a new record level. Their strategic distribution of plants and depots enabled the company to provide an exceptional service to their customers and to take full advantage of the growing demands.

New plants have been commissioned at Hull and Carshalton and these have increased the range and volume of the company's production of intermediates and speciality chemicals, for which there is a steadily growing demand.

World shortage of phthalic anhydride necessitated the company's continuous phthalate plasticizer plant being operated at below its capacity for much of the year. Their associate company, GRANGE CHEMICALS LIMITED, have recently announced that they intend to construct a plant with a capacity of some 15,000 tons a year for the production of phthalic anhydride.

The plant will be the first in Britain to use orthoxylene, a product of the petroleum industry, as raw material. The new structure will be sited adjacent to the Distillers Company's chemical factory at Hull, which will operate it on behalf of Grange Chemicals.

More Hangars at London Airport

To meet the maintenance requirements of their increasing air fleet, BRITISH EUROPEAN AIRWAYS have added a new east block to their engineering base at London Airport. This extension comprises two hangars of five bays, each hangar being 900 ft long by 142 ft wide by 40 ft high.

The aluminium hangar doors by Esavian, a view of which is shown in the accompanying illustration, are in two 900 ft lengths, each comprising a number of unattached sections driven by power mullions. The leaves fold back in such a way that a clear opening of 168 ft can be provided at any of the bays as required. Power for operating the doors is collected through trolley arms from bus-bars in the hangar roofs. This equipment, as well as the insulators, power cut-outs and cabling, has been designed and manufactured by BRITISH INSULATED CALLENDER'S CABLES LIMITED.

Each bay has its own panel for the individual control of lighting and power. There are 22 miles of lighting provided by 12,400 cold cathode 9 ft tubes. The lighting can be operated in three stages, each stage bringing in one-third of the lights. At floor level, each hangar bay is provided with five pits which give a variety of socket outlets for electric power, ranging from 100 amp three-phase to 15 amps at 24 volts. These services were cabled throughout by the BICC organization.

In all, BICC have supplied about 250 miles of cables of various types for the electrical services. Types provided include pvc insulated; pvc wire armoured and pvc sheathed; paper insulated lead covered and PILC with wire armouring; and mineral insulated copper sheathed.

Thorn and AEI Get Together

A few weeks ago, ASSOCIATED ELECTRICAL INDUSTRIES LIMITED and THORN ELECTRICAL INDUSTRIES LIMITED announced that they were to merge their respective interests in the manufacture and sale of cathode-ray tubes and radio valves.

The productive capacities of the two companies include factories at Footscray, Harlow, Rochester and Sunderland, and these resources are now being pooled. A new company, THORN-AEI RADIO VALVES AND TUBES LIMITED, has been formed and began trading on the first of this month.

All AEI's interest in radio valves and cathode-ray tubes for the entertainment industry will be transferred to Thorn-AEI Radio Valves. AEI, however, will continue to manufacture valves and cathode-ray tubes for industrial purposes.

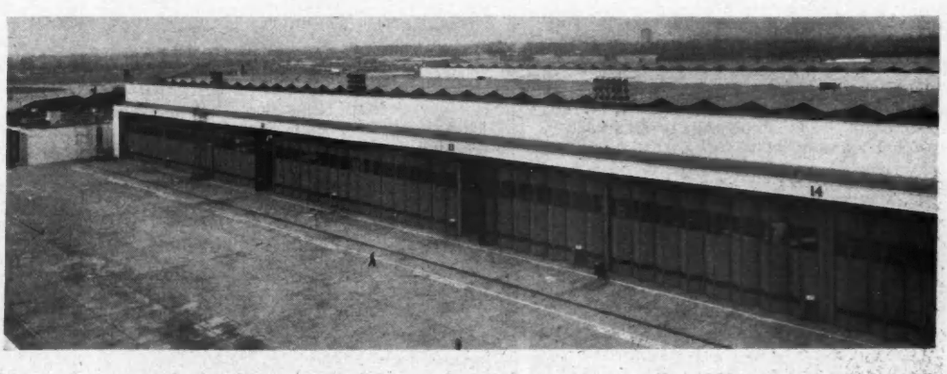
Chemical Plants for Northern Ireland

Another multi-million pound chemical plant is to be constructed by the DU PONT COMPANY in Northern Ireland, also at Maydown in County Londonderry. The decision has been made some twelve months after the start of neoprene synthetic rubber production at the first Du Pont works at Maydown.

The new plant will manufacture isocyanates, a raw material used in the production of urethane foams. These substances are produced in a variety of densities, varying from complete rigidity to extremes of softness and flexibility.

They enjoy a wide range of uses, including insulating panels for refrigeration and sound proofing, building panels and partitions, cushions, shock absorbers, lightweight linings for coats, interior wall-surface coverings for aircraft and railway coaches, and buoyancy apparatus for boats.

Construction will begin later this year, with a building force of some 500 men recruited locally. Between 125 and 150 workpeople are expected to be required when the plant commences operation in 1963.



East Block extension at London Airport showing the aluminium hangar doors by Esavian. These are in two 900 ft. lengths and can be folded to give clear openings of 168 ft at any of the ten bays.

Improved Forms of Industrial Graphite

The authors stress that even though the graphite industry produces many tailor-made grades, it is important to consider their cost. Some of the newer ones are expensive and will have restricted use.

By F. K. Earp, A. R. Ford and R. K. Hurden
Morganite Carbon Limited

IN RECENT years there has been much research and development in the field of carbon and graphite technology. Some of it has received fairly general publicity and a great deal has been carried out by the industry as part of its consistent policy of developing grades of material specifically for particular engineering applications.

Within the terms "carbon and graphite" must be included all those forms of industrial material based on amorphous carbon, natural and artificial graphite; many such manufactured forms exist, and claims that a particular graphite is superior in properties and performance must always be considered against the background of the very wide range of possible engineering applications, and the particular properties required.

Some appreciation of the complex technology involved may be judged from the fact that Morganite Carbon (until recently the Carbon Products Department of Morgan Crucible Company) produce and sell over 200 different grades of industrial carbon and graphite, a third of these having been developed in the last 10 years.

Research in other (allied) industries and in various research organizations has recently led to a wider interest outside the main carbon industry in this country, in Europe and in the USA; some of the recent "discoveries" represent rediscovery of techniques and materials, which, in one form or another, have been in use by the industry for a number of years. For instance, impregnation by materials such as furfuryl alcohol and sugar for densifying industrial carbon and graphite has been known in this country and in the USA for 25 years, although recent publication has revealed new uses and covers improved process methods.

Early Reactor Graphites

The general increase in the rate of graphite development has been due in part to the international interest in graphite for nuclear and missile applications. Considering first the nuclear field, we know that graphite is a good and convenient material as a moderator and reflector in thermal reactors, but this is true only if the graphite is low in certain neutron absorbing elements, notably boron and some of the rare earths, and is of a consistent quality, particularly with regard to density and orientation. Thus, for first generation thermal reactors, including those of the Calder Hall type, the need was for conventional graphite of consistant purity and density, and this has been produced in thousands of tons.

The development of thermal reactors more efficient than the Calder Hall type could follow any of many courses, but in this country the aim has been to raise the outlet gas temperature. A significant rise in temperature is obtainable by replacing uranium metal fuel by the oxide and contain it in stainless steel or beryllium in place of Magnox, as in the advanced gas cooled reactor.

A far larger rise in outlet gas temperature and efficiency is possible if the limitations resulting from the use of a metallic can and a non-inert coolant are removed. This principle has been used in the high temperature gas cooled reactor system, being exploited by OEEC under the Dragon Project, and in the US the Peach Bottom Reactor being built for a group of electrical undertakings.

Impermeable Reactor Graphites

The most serious problem in this system is the selection of a suitable fuel container material which needs to be stable and strong at high temperatures and high neutron fluxes, and above all needs to have a low permeability to fission products. Graphite is one of the few materials which satisfies most of these requirements, but in its conventional form is far from impermeable.

Much early work on making graphite which is impermeable at high temperatures (as opposed to conventional resin impregnated graphites which are impermeable at low temperatures) was carried out at RAE Farnborough, who developed, among others, an impregnation process using furfuryl alcohol.

In principle, this process is quite simple, but in practice great care has to be taken to produce a sound product with the desired low permeability and other properties. The method used is to impregnate a conventional graphite body with catalysed furfuryl alcohol or one of its derivatives, cure and carbonize the resin by slow controlled heating. This process is repeated one or more times depending on the degree of impermeability required, and is followed by a final graphitization. In theory it is possible to make any graphite impermeable by this treatment, but in practice, the number of necessary treatments form a considerable economic factor.

A very close-textured form of extruded graphite, known as Morganite EY9 grade, was developed about 8 to 10 years ago which has represented a considerable advance in the field of conventional graphites and it was fortunate that this material was available at the time the special treatments with furfuryl alcohol were being developed. This grade of material has been in wide use for casting moulds for uranium fuel billets for conventional gas-cooled reactors and also for specialized mechanical engineering applications. It requires far fewer impregnation treatments than other forms of industrial graphite at present available commercially in the sizes required, and it has been the main material used for producing dense graphites by impregnation. It is not ideal, and much work is going on to provide better materials, although the economic factor is again important since any improvement designed to reduce the number of necessary treatments must not involve so great an increase in production costs that the advantages are lost. Some idea of the properties of Morganite EY9, compared with its impregnated form and with conventional moderator graphite can be judged from the figures in Table I. The microstructures of these three grades are shown in Fig. 1.

TABLE I:—*Properties of Three Graphite Materials*

Property	Reactor Graphite	Morganite EY9	Furfuryl Alcohol Treated EY9
Bulk density, gm per cc	1·7	1·7	1·80
Compressive strength, lb per sq. in	4,700	10,000	—
Transverse strength, lb per sq. in	2,100	3,600	5,700
Modulus of elasticity, lb per sq. in	$1·5 \times 10^6$	$1·8 \times 10^6$	$3·0 \times 10^6$
Thermal expansion, 0 to 300° C, per °C	$1·6 \times 10^6$	$2·0 \times 10^6$	$2·1 \times 10^6$
Thermal conductivity, 0 to 300 °C, cgs units	0·4	0·15	0·18
Specific resistance, ohm-cm $\times 10^{-6}$	0·65	1·9	1·5
Pore size distribution	65 per cent 1 to 20μ	95 per cent < 1μ	—
Permeability, sq. cm per sec	2	$1·5 \times 10^{-6}$	1×10^{-4} – 1×10^{-6}

In the missile field, graphite has long been of interest because of its high sublimation point, strength at very elevated temperatures, and its thermal shock resistance. These properties are desirable for both rocket nozzles and heat shields. Unfortunately, conventional graphites do not have properties which entirely satisfy the requirements of modern rocket designs and fuels, in particular they lack erosion resistance.

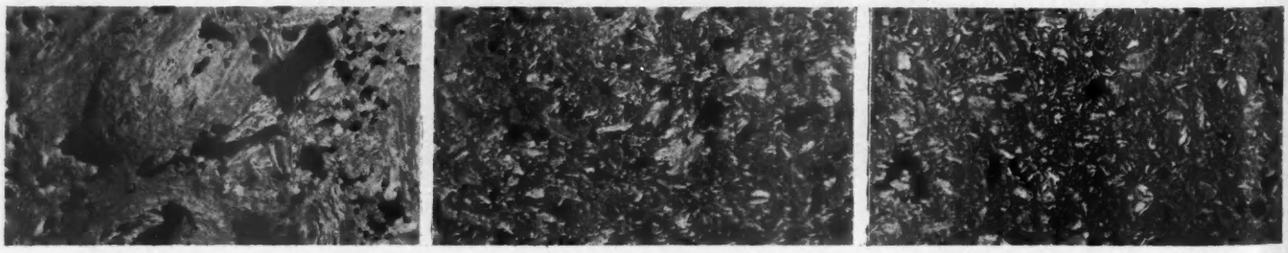
Pyrographite

There has been much development designed to produce improved graphites for these applications, and one of the materials produced is pyrographite. As with the impregnation process mentioned earlier, RAE Farnborough did a lot of the early work on this material. Development of pyrographite into a production material has been carried out mainly in the US and similar processes are being investigated in the UK.

Pyrographite can be made as coatings 0·001 to 0·002 in thick on a conventional graphite base, or as free standing shapes up to about ¼ in thick. The area of these pieces is limited only by the size of plant which can be constructed. The basic method of production is to form graphite on the surface of conventional graphite by thermal decomposition of a hydrocarbon gas. This process has to be carried out at temperatures in the region of 2,000° C, and it is necessary to control both the furnace temperature and atmosphere very closely to prevent trouble due to the different thermal expansions of the base and the pyrographite, and to prevent the formation of sooty deposits. The material produced can be subjected to annealing treatment to modify its properties.

Pyrographite is a very strong, impervious material with good electrical and thermal

Fig.1 Microstructures of graphite: (left to right) reactor grade A (Magn. × 50); Morganite EY9 (Magn. × 100); Hawker Siddeley-treated graphite (Magn. × 100).



conductivities in one plane and poor in the other; it also has good erosion resistance, and good oxidation resistance up to about 1,000° C, about one order of magnitude better than conventional graphites.

Importance of Cost

However, the present cost of pyrographite material is considerable, and although a marked reduction in cost can eventually be expected it is likely, as with all these newer types of graphite, that their economic cost will always be high in relation to the cost of conventional graphites and their applications will necessarily be restricted to those special applications where any improved properties may warrant the increased cost.

It is as well to point out that in the great majority of engineering applications where industrial carbon and graphite find a place, the industry is concerned to improve its grades of material without unduly increasing its costs. In applications like refrigerator seals, rotary pump vanes, mechanical shaft seals, transistor moulds and the like, where considerable export business may be at stake, the industry directs much of its technological effort to more efficient methods and to the development of improved "tailor-made" grades by economically attractive processes.

Oxidation Resistance

One property which holds back the further extension of applications for industrial graphite is the relatively poor oxidation resistance of these materials. Conventional graphite or graphites treated with carbonizing impregnants such as furfuryl alcohol are not usable for extensive periods of time above about 500° C in air, and an increase of only 100° C would measurably increase the number of engineering applications where graphite could be utilized. Some idea of how the graphite technologist may vary at will a property like oxidation resistance, may be gained from the fact that grades of material are in production today where the oxidation rate at 600° C in air can be made to vary by several hundered times. The main problem is to improve the oxidation resistance without sacrificing many of the other properties desired. For this reason, except perhaps in rocket applications, pyrographite provides no answer since in the main, low friction at rubbing surfaces is a parallel requisite. In this country, work is proceeding on these problems; it is possible to say that there is now an excellent chance that special graphites will soon be available with greatly improved oxidation resistance for use in mechanical engineering applications such as high temperature self-lubricating bearings and seals. An interim solution is represented by a grade known as Morganite EYX78, whose oxidation resistance is compared in Table II with certain other materials. This grade is, however, not yet available in large sizes and is not suitable for nuclear applications, since it does not meet the high purity required.

Another recently reported material is recrystallized graphite. The method by which this material is made has not been disclosed, but it probably involves the use of high temperatures and very high pressures to compress conventional graphites. Its cost is likely to be high, but the properties to be expected from it, such as high density, are likely to create much interest.

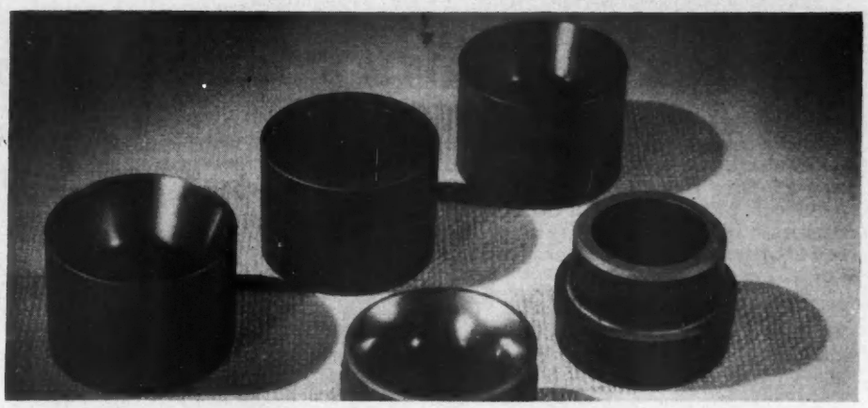


Fig. 2 Rocket nozzles made in electrographite (Morganite EY9106).

TABLE II:—*Oxidation Rates under Comparable Conditions*

Material	Oxidation rate at 600° C, gm per sq. m per hr
Pyrographite	3·9
Furfuryl alcohol treated EY9	8
Nuclear graphite ..	40
Morganite EY9106 ..	25
Morganite EYX78 ..	3

Table III shows some of the published figures on these graphites together with electrode graphite and specialized mechanical carbons and graphites for comparison. Pyrographite is unique in its strength and high orientation; the others are interesting for their low permeability at high temperatures and increased strength. Conventional mechanical carbons and graphites have been used for many years in a wide variety of industries where their chemical inertness, electrical and thermal conductivity, high temperature stability, low friction, and non-seizing characteristics, coupled with reasonable costs, have been of great importance.

Property Comparison

It is obviously very difficult to see which of the many existing applications could be better satisfied by the new graphites, and even more difficult to predict new uses for these materials, but by considering each of the major properties in turn it may be possible to see in which fields these new materials will be of value.

(i) Impermeability.—Most of the new materials discussed have low permeabilities, and if it is necessary to operate graphite at above 200° C, the limit of resin impregnants, or 350° C the limit of metal impregnants, then they will have advantages. However, there are a limited number of applications calling for impermeability at high temperatures, and for some of them, for example rotary seals, these materials are hardly likely to be suitable, since they have not been designed with frictional characteristics in mind. Metallurgical processes involving the use of reactive metals such as silicon and aluminium are a possible outlet, but for metals which do not wet graphite, there is insufficient technical advantage to warrant the increased cost at present.

(ii) Electrical and Thermal Conductivity.—Only pyrographite is really significantly better than the conventional graphites in these properties, but even here it is difficult to visualize how it can be employed until the present size limitations of this material have been overcome. It is possible, also that pyrographite might be usable as a high temperature electrical conductor, or thermal insulator in inert or reducing conditions.

(iii) Strength.—Some of these materials have very high compressive and transverse breaking strengths, but like all carbons and graphites, they have relatively poor impact properties. It is unlikely that applications will be found on these grounds alone, since conventional treatments with metal and synthetic resins will normally produce the desired increase in strength.

(iv) Thermal Expansion.—Again pyrographite is unique and recrystallized graphite is unusual in this respect. The considerable anisotropy in the thermal expansion of these two materials is more likely to hinder rather than help in finding new applications.

(v) Erosion Resistance and Oxidation Resistance.—Most of these new materials have improved erosion and oxidation resistance, and it is in fields where these properties are important that applications are likely to be found.

Considering the general picture it would appear that these new materials have interesting properties, and these properties may make them more suitable than existing conventional graphite in a few fields, especially those for which they were developed, but they are unlikely to replace conventional materials on a large scale, on the basis of cost if for no other reason, but may well open up new applications as yet unexplored. They must, therefore, be added to the list of tailor-made graphites, each one of which is of value in a particular range of applications.

Suffice it to say that the research by industry and others continues at an increasing rate, and has been much stimulated by recent developments. Long experience has shown that graphite technology will still need to be directed to the production of specialized grades, each developed to meet a particular combination of properties demanded by a particular engineering application. New techniques in themselves will not create new applications, but will add greatly to the ability of the graphite technologist to produce tailor-made materials to meet increasingly exacting conditions.

TABLE III:—*Typical Properties of Carbon and Graphite Materials*

Property	Pyrographite with grain "a"	Pyrographite across grain "c"	Recrystallised graphite	Electrode graphite	Mechanical carbon Morganite grade CY10	Electrographitic carbon Morganite grade EY9106	Metallised carbon Morganite grade MY3D	Resin impreg. carbon Morganite grade CY2C
Bulk density, gm per cc	2·19	2·19	1·95	1·55	1·60	1·72	2·5	1·85
Tensile strength, lb per sq. in	18,000	4,800	—	700	4,600	3,000	6,000	2,800
Compressive strength, lb per sq. in ..	67,000	17,000	12,500	3,500	23,500	10,000	45,500	28,000
Transverse strength, lb per sq. in ..	15,000	—	5,500	2,100	7,500	5,000	11,000	8,000
Mod. of E., lb per sq. in	16×10^6	10×10^6	$2{\cdot}4 \times 10^6$	$0{\cdot}5 \times 10^6$	$1{\cdot}6 \times 10^6$	$1{\cdot}0 \times 10^6$	$2{\cdot}6 \times 10^6$	$1{\cdot}96 \times 10^6$
Thermal expansion, 0-300° C, per ° C ..	$-0{\cdot}23 \times 10^{-6}$	23×10^{-6}	$0{\cdot}8 \times 10^{-6}$	$2{\cdot}0 \times 10^{-6}$	$3{\cdot}5 \times 10^{-6}$	$4{\cdot}5 \times 10^{-6}$	$5{\cdot}3 \times 10^{-6}$	$5{\cdot}0 \times 10^{-6}$
Thermal conductivity (cgs units), 0-300° C ..	0·9	0·008	0·39	0·25	0·020	0·20	0·040	0·031
Specific resistance, ohm-cm × 10^{-3}	0·25/0·6	500	0·8	1·0	3·9	2·25	1·0	3·55
Permeability, sq. cm per sec	Leak-tight to helium at 10^{-6} mm Hg	—	5×10^{-6}	4	3×10^{-2}	8×10^{-1}	1×10^{-7}	1×10^{-7}

Printed Circuits Made Without Drawings

The electronics industry has found the printed circuit quick, cheap and efficient in large scale production. A new method of one-off production makes it equally useful in development and teaching work.

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SINCE the early 'fifties printed circuits have been widely accepted in the electrical engineering industry as a mass production technique showing significant advantages in speed, reliability, repeatability, wastage rate and labour cost over more conventional methods of wiring electronic and light current assemblies. It is tempting, therefore, to wonder whether, if they could be made practicable on a one-off basis, printed circuits might be used even in the development laboratory.

At first this does not seem a very promising idea (though it has not been without advocates[1]). Once a printed circuit has been made, changes in the configuration of the conductors are difficult; indeed, they usually involve starting all over again. Thus it appears that using a printed circuit would limit development simply to changing component values. However, experience indicates that development engineers find that the advantages of carrying out development on printed circuits are fairly substantial. The most striking is that development models are much more like production models, and, in consequence, the transition from the first to the second tends to be much simplified, saving money and reducing the time between the specification of a new electronic system and its appearance on the market.

Environmental and reliability testing are aided if it is possible to produce small batches of a developmental circuit as soon as the laboratory tests suggest that it has the required performance. Among other advantages, less obvious but none the less real, are the ability to build up systems which are formed by large scale repetition of relatively simple parts (as in digital and analogue computers), the possibility of using laboratory printed circuits in the first prototype if pressure of time demands (and it usually does), and a very noticeably slower rate of deterioration of a printed assembly compared with the more familiar "rats nests" under the impact of the actual process of circuit development. This last is quite noticeable, and is perhaps the reason why circuit development engineers who are very doubtful initially about the use of printed circuits tend to become enthusiastic converts once they have some experience of them. It would seem, indeed, that wider application is largely held in check by consideration of cost.

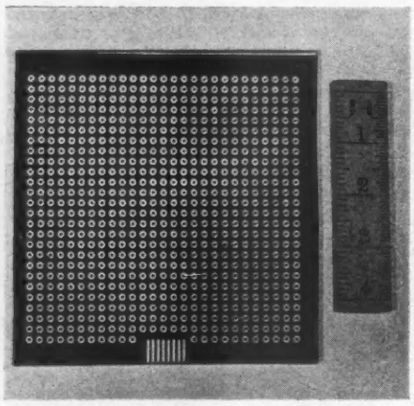

Fig. 1 A Perspex plate printed with the ring matrix pattern. Printing is by the silk screen process, using an ordinary oil based ink.

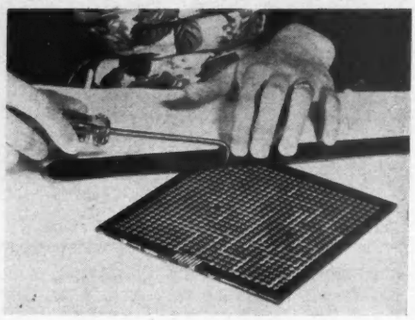

Fig. 2 Cutting a ring matrix negative. A suitably designed drag-knife and a straight-edge are the only equipment required.

All this encouraged a search for a new technique of printed circuit production which would be aimed at economic use on a "one off" basis in the laboratory, and having the following features:—

(1) it must be quick,
(2) it must lend itself to modifications,
(3) it must need no special skill to operate it, and
(4) most important of all, the capital equipment it demands must be very cheap.

The last point really arises out of the first. If the engineer is to get quick results the necessary production facilities must be provided on so lavish a scale, relative to anticipated demand, that unused capacity is almost always available. Clearly a facility which lies idle for all but a few per cent of its time cannot afford to carry heavy capital charges.

Making the Negative

The first stage in any of the commoner ways of manufacturing printed circuits is the production of a negative. Usually a four times full size drawing of the required circuit is prepared on fashion board, the conducting areas being blocked-in in black. This drawing is then photo-reduced on to a high contrast photographic plate, in which conducting areas appear transparent and non-conducting areas are opaque. Negatives made in this way are obviously expensive, particularly in drawing office time. It seemed evident that this was the first stage in the manufacturing process at which to seek some simplification. What was needed was an easy method of determining layout, and a technique for making negatives which, if possible, did not use photography at all.

CONVENTIONAL DIFFICULTIES

The most obvious way to tackle making a negative is by drawing one directly, using opaque ink or paint on some transparent material. With this method, the difficulty is that to produce a circuit with sufficient copper area to permit soldering where necessary, to give good insulation clearances between adjacent conductors, and yet to keep the circuit compact, demands such close tolerances on drawing that more than average draughting ability is required. The process is also very slow and tedious, and only yields the very high contrast negatives required for printed circuits if a rather thick ink is used, which makes skill in drawing even more crucial.

Another defect is that the resulting circuit tends to be in the form of terminal rings joined by narrow strips of copper, leaving large areas of copper to be etched away. This is normally avoided in conventional drawn circuits by making conductors in the form of large irregularly shaped areas with only small insulating margins between them. In this way premature exhaustion of etch baths is avoided. The third fault is that the method does nothing to reduce the layout problem. Evidently some further development was required.

After a number of trials the solution has been to have "Perspex" plates cut to the required size of the negative and printed with an opaque ink pattern in the form of a rectangular array of transparent terminal rings which entirely cover the working area of the plate. We use rings of 0·06 in inside diameter and 0·156 in outside diameter, arranged with their centres on rows and columns 0·2 in apart. Printing is by the

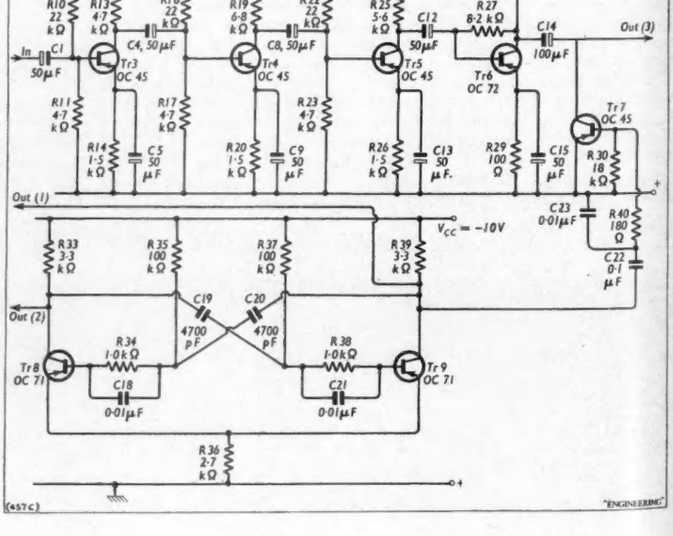

Fig. 3 A Mullard circuit for part of a chopper type dc amplifier. Layout was more than usually difficult because of the many decoupling capacitors and the multiplicity of outputs.

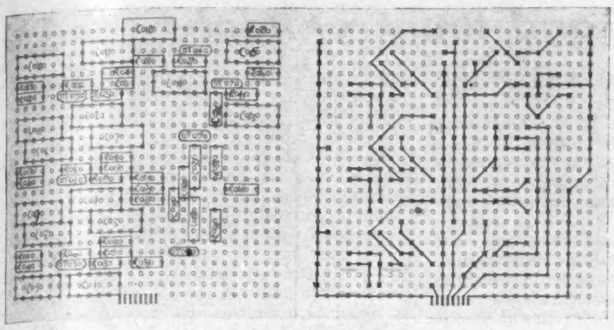

Fig. 4 Work sheet for the circuit of Fig. 3, showing (a) components and (b) connections. Normally they would be drawn on the same sheet, the components in red and the connections in black.

silk screen method and presents no particular difficulties; it is convenient also to print a plug (transparent in the position for conductors) at the same time (Fig. 1). Making a negative only involves selecting those rings which are to be used as terminals and joining them by cutting transparent lines in the opaque regions separating them. No marking out is needed, and the rings provide a dimensional grid.

The only tools needed are a suitably designed drag-knife (Fig. 2) and a straight-edge. Large vacant areas to be etched away are filled with unused rings, and the amount of copper to be removed is reduced to nearly half what it would be if simple line connections were used.

Except in very unusual circuits, the unused rings have no effect on the operation of the circuit. Adjacent rings have a capacity of less than one quarter of a picafarad, and the dry breakdown voltage is over 3,000 volts. They can sometimes, with advantage, have a line cut through them to connect them together and to earth, in which case they may act as an electrostatic screen. In extreme cases, where special circuit conditions demand their eradication, rings can easily be touched out by hand on the negative simply by using black drawing ink painted on with a small brush.

The lines joining terminals pass through unused rings. Mechanically the result is to anchor them even more firmly to the printed circuit board, and electrically the only effect is a small drop in resistance and increase in current carrying capacity. A 0·06 in wide track cut in this way, it has been found, can be run safely at up to five amperes.

Circuits made like this tend to be less compact than their more conventional counterparts with the size of rings and spacing between rows and columns quoted here. If the rings are reduced in size the distance between centres can be reduced by a factor of up to two, and with a 0·1 in grid there can be no objection on grounds of compactness. With a coarser pattern, however, less skill is needed in cutting the lines, and the resulting circuits are usually sufficiently compact. Thus, to some extent, there has to be a choice between (*a*) high compactness with increased skill in manufacture, and (*b*) a lesser, but usually acceptable, degree of compactness with less highly skilled and quicker manufacture.

WORK SHEETS

The only problem remaining is layout, and several solutions to this are possible. The simplest uses work sheets printed with the same pattern of rings as the negative, but in positive form—that is, with the rings dark on a light background. A series of transparent plastic stencils is manufactured with holes shaped to the circuit plan areas of the various types of components used, with the position of terminal rings indicated. Given a theoretical circuit diagram with the types of components identified, a layout can fairly easily be sketched out using the stencils. The component plans are drawn in first and the connections afterwards. In difficult cases two or three attempts at a layout may be required, but usually the first is satisfactory. The work sheet marked with the required connections can then be used as a guide to cutting the negative. As an example, a circuit (Fig. 3), the work sheet made from it (Fig. 4), the negative that resulted and the final printed circuit (Fig. 5) show the main steps of the process.

This "ring matrix" technique for making negatives has all the necessary requirements. No photographic equipment and no special skills, which cannot be acquired in a day's work, are involved. A marked advantage of this process over the glass negative made by photography is the ease with which changes can be made. Provided that the cut lines are kept shallow, unwanted lines are readily touched out, using black drawing ink applied with a small brush, and new lines can easily be cut. On a single board, regions can be laid out by the ring matrix method and combined with other regions of special patterns cut either by hand, using a suitable knife or scraper, or even in an engraving machine where particularly difficult patterns are involved. This could be used, for example, in the manufacture of a strip-line RF head for a microwave receiver.

COST AND TIME

Once a satisfactory technique for negative production is available, printed circuits really do become an effective development laboratory tool. The circuits are manufactured by the photomechanical process, following closely the usual procedure for manufacture of small batches, described, for example, in Chapter 10 of Eisler's book.[2] Development and etching of the boards may be carried out in ordinary porcelain photographic dishes, in daylight and at room temperature.

It can now clearly be possible to establish facilities for very small scale production of printed circuits for a total capital expenditure well under fifty pounds. Thus the very low utilization factors encountered in the development application of printed circuits can be tolerated. A difficult circuit can take a considerable time to prepare, but more usually an hour or less is sufficient. Subsequent operations demand little skill: a simple negative can be cut in about forty-five minutes and a useable printed circuit can be available little more than one hour later. The board will be lying in the etching bath for most of the latter period.

Further Development

The ring matrix technique for negative production was developed in the Engineering Department at University College, Swansea, as a result of a pressing need for a low cost short run method of manufacture for use in development work and in advanced teaching. Though this need has now been very adequately met, further possibilities are being explored, including the application of the ring matrix method to negatives on thin flexible films and the direct production of metal printing plates from the work sheet without the use of photography. Detailed development of tools and materials also continues.

Negatives produced as described here have application beyond the small batch production for which the method was first developed. Because the circuit engineers can specify their printed circuits directly to the operative who cuts the negative, control of layout is by the people best fitted to determine it. A successful development negative can be used directly for mass production, avoiding the possibility of errors and unsuccessful layout modifications in the drawing office. Ring matrix negatives, if lacquered after completion, are far less susceptible to damage than their photographic counterparts, particularly when wet. They can be as compact as the more conventional type, if on a 0·1 in mesh, and can be used for double-sided circuits and for end plates for double-ended potted blocks, as used in guided missiles and military equipment. The ring matrix technique is the subject of a provisional patent application.

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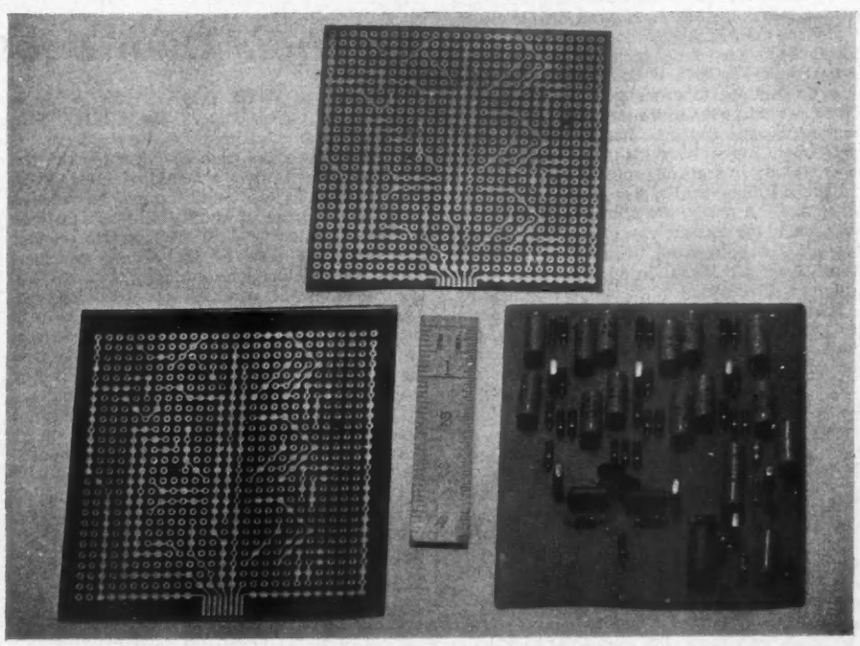

Fig. 5 The completed negative (left), an etched plate (centre) and the assembled module (right) corresponding to the circuit in Fig. 3.

On the Shelf

By Frank H. Smith

IN THE columns of the *Bookseller* there has been some to and fro on the subject of booksellers and libraries going in for fringe stuff such as gramophone records. Decca seem to be weighing in on the side of those in favour since they send me, as a librarian (sic), details of their Master Catalogue Scheme. I can have the Decca Group Main Catalogue, including Quarterly Supplementary Catalogues, for £3 1*s* each, the RCA Main Catalogue including QSCs for 19*s* each, the Decca Group Numerical Catalogue including Monthly Stickers at £1 12*s* 6*d* each, and the RCA Numerical Catalogue including Monthly Stickers for 7*s* 6*d*, or 5 guineas for the lot. All damned fine, but I do not happen to have a record player. A pity, because I do rather fancy those monthly stickers.

Catalogue collectors may be interested to know of Feffer and Simons Inc's *University Catalogue; Texts and Reference Books*. They call themselves publishers' international representatives and live at 31 Union Square, New York, 3. An enclosure in the catalogue is of interest as it lists a great number of publishers for whom F & S are representatives.

Here is one of those things that I tell you about without the faintest idea of its significance. From Institutul Politehnic, Biblioteca centrala, Brasov, B-dul I. V. Stalin nr. 3, R. P. Romina (I imagine), comes the first four volumes of *Lucrari Stiintifice* and I've left out all the little half-moons and triangles under and over the letters. Volume IV is divided into two parts—Seria Mecanica and Seria Silvicultura. I can almost guess at those two. I cannot tell the price because they offer a swap but the dates are 1956 (for Volume 1) to 1960. Oh, another thing. Those last two parts are split between Inst. Pol. Brasov (for the mecanica) and Inst. Pol. Orasul Stalin (for the silvicultura).

The Carnegie United Kingdom Trust's annual report has a diagram showing distribution of trust expenditure 1913-60. Of £6,029,208 expended, libraries and library activities amount to £2,167,799, which is 35·9 per cent. A pretty fair whack to devote to educating the masses. Only one other activity—community services—shows more than a million, and that chunk is divided into four different types of expenditure.

The Instituto Brasileiro de Petroleo, of Caixa Postal 343, Rio de Janeiro, have started a quarterly dealing with Brazilian petroleum, and they are anxious to exchange with similar and fringe-interest publications in this country. I've done my bit and tried like mad to work in something about nuts. Now it's up to you. (I might have brought in cracking, mightn't I?)

I think I mentioned a new journal *Cobalt* the other day. Anyway, the abstracts therein have been sent to me separately and *Review of Technical Literature* is presumably available in this form from Centre d'Information du Cobalt, 35 rue des Colonies, Bruxelles, 1.

Specialist trade directories are always useful and do not take up much room, so ask the Aluminium Development Association for their *Directory of Members, with Index of Products*.

It is quite extraordinary what strange hobbies get associated with leaders in various fields. An interesting book could be compiled, and I am sure that the Great Ones would not mind coughing up the information, (*a*) because of their enthusiasm and (*b*) because of the contacts it might provide. This is touched off by my meeting the chief of the American ASTIA organization—Armed Services Technical Information Agency—an electrical engineer by training and now in charge of the biggest factory for churning out information by machine in the world. His hobby is grandfather clocks, in any condition. Anybody with such relics who would like to be put in touch should ask me for his address.

The House and the Architect

An Anthology of Houses. Edited by MONICA PIDGEON and THEO CROSBY. *Batsford.* (50*s*)

At first sight this looks like another glossy picture book of international architecture; nice to hold, good to look at, ideal for ten minutes in a waiting room, but hardly a book to read. Closer inspection shows there is more to it than that.

In the few short paragraphs about each house there is a surprising amount of information. Type of client, special site features and principles of planning are discussed and details are given of materials and construction. Also there are annotated plans as well as the photographs and in some cases cross-sections as well. The captions are adjacent to the pictures—a simple virtue too rare in architectural publications—and there is even an index. In fact, so much information is given and the layout is so nearly systematic that one becomes abnormally critical.

Possibly some of the information, especially that on materials, could have been tabulated, together with details of the size of house and some idea of cost. Floor areas are given for some houses but not for others. On cost the authors say that "the economics of house building vary from country to country and no attempt has been made to provide costs for the various houses shown." This would be understandable if they did not go on to say that the price varies in almost direct ratio to the size. Does it? The standards of equipment and finish alone seem to vary widely. Costs per square foot related to date and the normal range of house costs for the particular country would have added greatly to the significance of the other information.

The houses themselves are what is normally described as contemporary, but their standard of design is much higher than this word has come to imply. Almost all have been planned individually to suit particular needs; some are cold in feeling though crisp in detail, while others are warm and almost cosy. The American ones look richest, but that may be partly because one expects them to. Inevitably there are architectural and structural conceits in many of the examples, notably in the two from Italy and France, but in others the emphasis is all on the materials and detailing. The simple, almost self-effacing, designs will probably look best for longest and the "sets of boxes" prove more adaptable to changing conditions than the open-planned houses.

The book is apparently aiming to stimulate those wanting a house to commission an architect to design one. This is very laudable but many architects complain that it is simply not economic to design individual houses of the size in demand today; they have almost as much trouble with bye-laws, planning permission and the supervision of the contract for a single house as for an estate or a multi-storey block, while the fee is but a small fraction of that for the larger scheme. The houses shown in this book have clearly each been designed with particular care, if not with love, and one is tempted to wonder how many were built for otherwise important clients and how many by young architects early in their careers; a significant proportion are the architects' own houses. If it is uneconomic for architects to design individual houses how much more so for the structural engineers and the consultants for the services. Yet several of the houses shown must have needed appreciable engineering attention.

The demand for the individual house is likely to remain, but more and more people will have to become content with group designs, just as in the case of motor cars. This may not be as sad as it seems, and certainly some recent group housing schemes have been more than just promising. The Span houses at Blackheath—one of the few group schemes included—stand up well beside the others and show that comparatively cheap housing can be a positive addition to the scene. Perhaps the authors could now give us a companion book surveying the best of the standard house designs in different countries. They could start with the purely traditional and then show where modern methods have been successfully applied—for economy rather than effect. The building industry is bound to become more technological and the sooner the house builder starts to come to terms with engineering the better he will understand it and the more attractive and efficient his works will be when he does have to move away from purely traditional construction.

R. J. M. SUTHERLAND

By Their Own Bootstraps

The Attack on World Poverty. By ANDREW SHONFIELD. *Chatto and Windus.* (21*s*)

Andrew Shonfield, economic editor of the *Observer*, has written a book of outstanding importance. In less than 250 pages, he achieves three feats, any one of which would have justified a volume to itself. First, he assembles under one cover the facts of the diverse problems facing the developing countries of Asia, Africa, Central and South America, and discusses practical ways in which they could be helped to help themselves. Secondly, he outlines the problems of international investment, basing his exposition on a reasoned critique of the methods of the World Bank. Thirdly, he offers an analysis, magisterial in its clarity, of the multifarious functions and bewildering interrelations of no fewer than 19 leading United Nations bodies, which, directly or indirectly, are concerned with aid to the developing countries.

Mr. Shonfield realistically points out that there are countries in which effective use of foreign aid on a large scale is not feasible, because of educational, cultural, or more often political obstacles. He cites, for example, those Latin American countries in which the budget is overloaded with the cost of masses of officials who owe their jobs to political patronage. When President Frondizi in the Argentine decided courageously to tackle the superfluity of civil servants in 1959, he ordered that all should be at their desks by 9 a.m. The ensuing chaos when the several different holders of the same jobs all turned up to use simultaneously the desks at which they had been sitting in shifts revealed the magnitude of a problem common throughout Latin America. Again, most of these countries have to cope with a powerful military class. A government which defiies the officers will end up by having to fight them or mobilise its own group to overawe them.

On the other hand, Mr. Shonfield short-lists India, Mexico, and Brazil, as countries ready to use foreign aid on a scale that would speed up their rate of growth in the short term and achieve their complete economic independence in the longer. It may seem harsh to back only the winners, but the total amount of aid available is limited, and if the aim is to create as quickly as possible a number of new economies capable of rapid progress under their own momentum, then these three are Mr. Shonfield's choice.

After pointing out the difficulties that prevent an exporter of raw materials and primary products, like India, from substantially raising the volume of its exports to the West, Mr. Shonfield suggests that the developing countries could help their balance of payments by trading more among themselves. Much more food would be grown in the surplus agricultural area of South East Asia if there were an assured market for it,

but it only needs one good rice harvest for Burma to be faced with surplus stocks. With inadequate storage space, the rice rots, the price falls, and next season the peasant grows less. India does not buy Burma's surplus because New Delhi is not ready to allocate its dwindling foreign exchange reserves for additional rice imports. Mr. Shonfield urges that, where necessary, barter trade should be encouraged. This offends the multilateral trading doctrines of the International Monetary Fund, but Mr. Shonfield argues that these were intended to provide rules of fair play for commercial rivalry, between developed industrial countries. Should they be used to prevent the level of output and consumption in the developing countries from rising?

The exports of Asia and Africa, originally developed by Europeans, are largely directed outwards by sea to Europe and America, where the markets for raw materials existed. Now, however, with the new Asian and African effort to diversify output, including the whole range of advanced industrial products in which the developing countries are bound to be at competitive disadvantage for some time, the need is to start trade moving in new directions. On grounds of economy alone, regional trading groups ought to appeal to the Western donors of aid. It would be cheaper to finance industrialisation if the new industries were from the start planned to reach the most efficient size by looking beyond their national markets. Apart from the vast waste of resources which goes on now because these nations do not exchange their surpluses with each other, there is also the waste of setting up new high-cost industries in markets too small to enable them to pay their way. It is, for example, discouraging to see Burma building a new steel plant which cannot be economic for years to come. The Burmese could concentrate their scanty resources on more urgent needs if they struck a bilateral bargain with India to barter steel for rice.

Mr. Shonfield concedes that a series of competitive trade agreements reached between pairs of underdeveloped countries could produce more political quarrels than useful business. That is why the United Nations regional organisations, like the Economic Commission for Asia and the Far East, are important as expert coordinating bodies, and as forums where inevitable trade wrangles can be sorted out with factural information. Since the General Agreement on Tariffs and Trade has demonstrated the effectiveness of such a forum in which nations have to justify their actions in public, Mr. Shonfield believes that the first step should be to induce GATT to draw up special rules to suit the developing countries.

Mr. Shonfield next tackles the problem of how to find useful work for millions of unemployed. Surely the solution is to put these millions to work on capital projects. That, of course, is what the Communist countries do: by using forced labour they are able to build new factories without foreign loans. Because India, and other free countries, reject forced labour, it is wrong, Mr. Shonfield plausibly asserts, to compel them to use large amounts of foreign labour-saving equipment—since this is something on which World Bank loans can be spent—and so keep millions idle, producing nothing.

Mr. Shonfield urges the World Bank to get away from its preoccupation with machinery and equipment. Except for big dam projects, agricultural investment in the developing countries rarely figures in its lending. Yet there is vast scope to increase the output of food if a small addition to the resources of peasants were applied in millions of agricultural holdings. The trouble is that what the peasant needs is not conventionally called "capital." Thus, it is regarded as legitimate to lend capital to India to finance fertiliser factories which will eventually raise agricultural output, but if it is suggested that, in the interval before the factories are in action, New Delhi should borrow cash to buy fertiliser abroad, that is classified as current consumption and does not qualify for a World Bank loan.

The planning authorities in the free Asian countries also shrink from putting masses of peasants to work (on land drainage schemes, for example) because the workers have to be paid something extra, and that increases the demand during the agricultural off-season, for consumer goods, especially food. The planners fear to invest money in this way without additional supplies of consumer goods lest they create national scarcities and so force prices up to the disadvantage of the whole population. In these circumstances, it would seem reasonable to try to persuade the World Bank to classify as legitimate capital investments loans intended either to buy raw materials, such as fertilisers, to increase badly needed supplies in the interval before a plant becomes operative, or to provide the extra consumer goods needed to meet the demands of workers engaged in building an approved plant.

Whatever may be thought of some of Mr. Shonfield's often admittedly controversial recommendations, he has gathered an enormous array of hitherto inaccessible facts and figures, and his took should be obligatory reading for all concerned with one of the biggest problems of our times.

JOSSLEYN HENNESSY

Tools to Save Life

The Road to Modern Surgery. By HUGO GLASER. *Lutterworth Press.* (30*s*)

The author of this book has succeeded in producing a fascinating historical review of the developments within the last century of techniques and instrumentation in the medical and surgical fields. In the simplest possible manner he shows how the various branches of medicine and surgery have progressed up to the present day. Although written by a specialist, every subject is discussed in terms sufficiently simple for the layman to follow without effort. In so far as the medical aspects of the subject are concerned, be they anaesthesia, brain surgery, bacteriology, pharmacology or even such things as the common cold, they are discussed with the same degree of emphasis and interest.

For the non-medical reader there is no better book than this one, should he wish to acquaint himself with the rudiments of the medical science. It will enable him to have some degree of appreciation of the potentialities of medicine and surgery as at present practised. It gives the reader, in simple terms, an adequate understanding of the nature of the various pathological conditions of the body. The reader, while being under the impression of reading a story, is actually acquiring a great deal of factual knowledge about diseases and how they are now combated. He learns the physiology of anaesthesia, acquires a reasonable picture of the various remarkable operations which can now be performed, and obtains a general understanding of bacteriology, pharmacology, children's diseases, and problems connected with childbirth or even old age.

As the author describes in some detail the development of the tools and equipment used in the various medical and surgical fields, the book might also be of interest to engineers and physicists. It is more and more evident that the cooperation of the scientists and engineers in the medical sciences would alleviate many difficulties with which the medical men are confronted when developing new surgical techniques.

As a small point of criticism, perhaps one could say that the author leaves the reader with the overall impression that the contributions in the medical field were all due to medical men. Perhaps here one might mention that medical science has been benefiting from the knowledge of other sciences such as biophysics, biochemistry and biomechanics. In the latter, the engineering profession has contributed considerably towards the advancement of orthopaedic surgery.

J. M. ZAREK

No Moving Parts

Thermoelectricity; Including the Proceedings of the Conference on Thermoelectricity Sponsored by the Naval Research Laboratory, September, 1958. Edited by PAUL H. EGLI. *Wiley, New York and London.* (80*s*)

Thermoelectric Materials and Devices. Edited by IRVING B. CADOFF and EDWARD MILLER. *Reinhold Publishing Corporation, New York; Chapman and Hall, London.* (78*s*)

Electrical generators with no moving parts, long maintenance-free life and, at present, relatively low power output, are being specified in such applications as satellite and space vehicle auxiliary power supplies, for advanced propulsion systems in space vehicles, underwater cable systems, arctic observation stations, inaccessible mountain top beacons, and observation posts on uninhabited islands. By comparison with central-station electrical power plant, in which the main objectives in development are lower capital cost and higher overall thermal efficiency coupled with long life and a reasonable maintenance schedule, these special purpose generators must frequently have minimal weight or volume, may utilize exotic (and therefore expensive) materials and need not necessarily achieve a high thermal efficiency. For example, in a particular application, a useful criterion for assessment of a generator system might be not the "£/kW installed" of the central station but "total pounds weight of integrated power system (including any expendable materials such as fuel) per kilowatt hour of electricity supplied" over the complete working life. A generator which required the use of a chemical fuel might be lightweight and have a high efficiency but, when specified for duty over extended periods, have a prohibitively high weight penalty, even if the supply of fuel could be arranged; on the other hand, a generator with high initial weight but requiring no expendable materials, and even with fairly low overall efficiency, could have an advantageously low "lb/kW hr" factor.

With requirements such as have been outlined it is not surprising that scientists and technologists have been forced to reject preconceived ideas based on conventional prime movers and generators, and to consider again the known range of physical phenomena by which available energy can be converted to electrical power. Systems using direct generation principles came into being and, of several possible methods for which research and development programmes are at a relatively early stage, perhaps the most advanced in terms of total expended effort is thermoelectric power conversion, depending on the Seebeck effect in selected semiconductor materials. Although this effect (the flow of electric current in a circuit consisting of two electrically conducting materials when a difference in temperature is maintained

between the junctions) was first discovered by Seebeck in 1826 and a number of scientists (including Lord Rayleigh) have since considered the generation of electricity utilizing this phenomenon, the present resurgence of interest has been inspired mainly by the activities of the late Professor Joffé and his co-workers in the USSR. An additional feature of thermoelectricity is the utilization of the Peltier effect in semiconductors (evolution or absorption of heat when an electric current is passed across the junction of two dissimilar conductors) to provide cooling; this may be applied in small refrigerators, for temperature control, and in certain scientific instruments.

In the United States, with the forced pace of space research, it is hardly surprising that scientists working in this and allied fields have little time to prepare textbooks dealing in a detailed and thorough manner with rapidly developing, but yet embryonic, branches of technology. Consequently, there is an ever-increasing tendency to publish, with very little attempt at criticism or rearrangement to provide a concerted story, the proceedings of specialist conferences, university extension lecture courses and the like, if only to provide the eager scientific population of the United States and other countries with information, as much and as early as possible.

The two books now being considered fall to some extent into this category; however, it becomes evident on closer study that in both attempts are made to provide works of reference of a nature rather more permanent than last year's conference papers.

Dr. Paul Egli, who is associated with the Crystal Branch, Solid State Division, of the United States Naval Research Laboratory, edits *Thermoelectricity*, which incorporates papers presented at the Conference on Thermoelectricity sponsored by the Naval Research Laboratory in September, 1958; Irving Cadoff and Edward Miller, both of the Department of Metallurgical Engineering, New York University, edit *Thermoelectric Materials and Devices* which is based on a series of lectures given at the University in June 1959 and 1960. The two books are so similar in concept, length and price, being published at the same state-of-the-art in thermoelectricity, that comparison is inevitable. Indeed, the names of many of the contributing authors appear in both volumes, so that one can expect some similarity of outlook.

In Egli's book the 23 papers are grouped into five sections: fundamental concepts in thermoelectricity; basic parameters in thermoelectricity; chemical and physical properties of materials at high temperatures; measurement of material properties; and a concluding chapter, written by Dr. Egli himself. The titles of the sections give the clue that one cannot expect to find information on all aspects of current work on thermoelectricity. Dr. Charles Zener, of the Westinghouse Research Laboratories, whose staff have perhaps made the biggest contribution towards thermoelectric power, provides a stimulating introductory chapter; this, with a few embellishments, could form quite a useful monograph. Werner Teutsch, of General Atomics, then relates the thermoelectric effects with an exceptionally clear insight. Immediately following this, the reader plunges into detailed device design, still under the heading "fundamental concepts"! The section on "basic parameters" is excellent, with discussion of the physical properties important in thermoelectric materials, the principles of their measurement and provision of experimental data for a number of materials of interest. The next section contains papers on chemical-metallurgical aspects of various potentially-useful semiconductor compounds, the design of materials for thermoelectric power, liquid semiconductors, porous semiconductors and on thermionic diode generators. This last is an excellent paper in itself but the reviewer feels that the analogies between high pressure thermionic generators and thermoelectric generators are somewhat tenuous.

In the section on measurement of material properties there are nine useful papers on the techniques used in the determination of physical properties; some are review papers while others present details of work on particular materials. Dr. Egli's summary provides an excellent review of general requirements in thermoelectric materials and the important features in developing optimum properties.

The order of presentation of at least the first few chapters in Cadoff and Miller's book is logical. The first chapter deals quite adequately with thermoelectric phenomena and is followed by chapters on the basic thermoelectric circuit, the thermoelectric figure of merit, "thermionic emission thermoelectricity," the properties affecting the utility of thermoelectric materials, methods of measurement of these properties and two chapters dealing with the mechanism and measurement of thermal conductivity. The properties of a wide range of thermoelectric materials, many already familiar but also including ionic materials, liquids and molten salts, are discussed in some detail. Two chapters deal with the calculation of efficiency and design parameters of thermoelectric generators and there are also treatments of the design of devices for thermoelectric cooling based on the Peltier effect in semiconductors. Some results of experiments in cooling devices are also given. There is a substantial and useful chapter on the application of thermionic and thermoelectric power conversion to nuclear heat sources, both fission reactors and radioactive isotopes.

It may be concluded that both books contain a considerable amount of information on thermoelectricity, representing a more honest attempt than most to convert a set of separate contributions into a reference textbook. (Needless to say, the latter objective is not achieved, and one looks to the future for the appearance of a comprehensive and authoritative work on the subject.) The Wiley book wins on presentation and typographical layout; the Reinhold book is perhaps a little more complete in providing data on a wide range of materials. Both are good value for metallurgists, physicists, and electrical and electronics engineers who are entering the field of thermoelectricity for the first time. To the scientist already engaged in thermoelectric research the books offer a guide to areas where more work is needed and where further developments are likely to occur.

B. C. LINDLEY

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electronic Instruments

Semiconductors: Device Guide. GENERAL ELECTRIC CO. LTD., School Street, Hazel Grove, Stockport, Cheshire. Leaflet giving brief information on the company's range of semiconductors, and including a device directory and list of service types. 10 pp. ill.

Miniature Oxide Resistors. WELWYN ELECTRIC LIMITED, Bedlington, Northumberland. An account of the development and properties of Metox resistors, with an article on the "Total Excursion" circuit concept. Brochure, 12 pp. ill.

Plant and Equipment

Foundry Mixers. BAKER PERKINS LTD., Bedewell Division, Hebburn on Tyne, Co. Durham. Folder describes a complete range of mixers for the foundry industry and covers continuous mullers, continuous mixers, simplex mixers and a vertical sand mixer. 4 pp., ill.

Self-Priming Water Pumps. RANSOMES & RAPIER LTD., Ipswich, Suffolk. Two leaflets giving details respectively of the 1½P4 Mk II pump, with a capacity of 4,000 gph, and the 6P80 model, of 80,000 gph capacity. Each double-sided, ill.

Hydraulic Presses. FAWCETT PRESTON AND CO. LTD., Bromborough, Cheshire. Two folders, No. FP122 and No. 123, covering respectively the 10 to 50 ton range of laboratory, platen and stereo presses, and the 50 to 400 ton range for compression and transfer moulding of plastics. Each 4 pp. ill.

Melting Furnaces. GWB FURNACES LTD., PO Box No. 4, Dibdale Works, Dudley, Worcestershire. A catalogue detailing the company's Lectromelt furnaces and giving a general picture of design features over a wide range of capacities—from 200 lb to 200 tons. Loose-leafed, 44 pp., ill.

New Books

Calculus of Variations. By A. R. FORSYTH. *Dover Publications, New York; Constable, London.* (15*s* 6*d*)

Unabridged republication of this standard treatise. The author is concerned mainly with methods and solutions rather than with determinations of the weakest hypotheses under which the methods will hold. Consequently, over 150 examples are completely worked out to illustrate the application of 4 standard maxima and minima tests.

Modern Computing Methods. 2nd Edition. National Physical Laboratory, Notes on Applied Science No. 16. *HM Stationery Office.* (21*s*)

First, this is a working manual for all who engage in relatively complicated calculations; secondly, it provides the basis for courses in numerical analysis at universities and colleges of technology. Much new material has been added to this edition, including two completely new chapters—one on linear equations and matrices, the other on Chebyshev series.

Principles of Semiconductors. By M. G. SCROGGIE. *Iliffe.* (21*s*)

Elementary yet sound introduction to the properties and applications of semiconductors, enough basic theory being included to enable the newcomer to this subject to understand the more advanced literature. No previous knowledge is assumed and illustrations abound.

Association of Supervising Electrical Engineers Year Book and Technical Guide, 1960-61. 10th Edition. *Published for the Association by Fraser Pearce Limited, Brighton, Sussex.* (5*s*)

Television Receiver Servicing. By E. A. W. SPREADBURY. Volume 1: Time-Base Circuits. 2nd Edition. *Iliffe.* (25*s*)

The reader is assumed to have already a reasonably sound grasp of the principles of radio servicing. Comprehensive information is given on fault location and on the isolation of a faulty section from the rest of the receiver. There are important sections on workshop precautions and X-radiation hazards. This edition has been completely revised.

War planes of the Second World War: Fighters. By WILLIAM GREEN. Volume 3. *Macdonald.* (9*s* 6*d*)

The aircraft (both operational and experimental prototypes) of Japan, the Netherlands, Poland, Rumania and the USSR are the subject of this volume. Each description is illustrated with photographs and three-view, scaled line drawings.

The Reviewers

Mr. R. J. M. Sutherland, B.A. (Cantab.), A.M.I.C.E., has interests in all branches of civil engineering as well as in architecture and the history of technology. He is a partner in the firm of A. J. and J. D. Harris, consulting civil engineers.

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Dr. J. M. Zarek, Dipl.-Ing., B.Sc., is Reader in Engineering Science at King's College London. His chief interest is research into biomechanics.

Dr. Bryan C. Lindley is leader of the Future Studies Section at the Nuclear Research Centre of C. A. Parsons and Company Limited. He has recently become leader of the Physical Properties Section also. Earlier he worked with the Hawker Siddeley Nuclear Power Company and has carried out researches on combustion and the suppression of explosions.

Marketing

New Depot Facilities for Ulster Service

SANDERS AND FORSTER Limited, of Barking, Essex, and Stratford, London, manufacturers of standard steel buildings, and the structural engineering company of the CHAMBERLAIN GROUP of Companies, with headquarters at Buckingham Palace Gardens, London SW1, have recently supplied and erected one of their large tied-portal type standard steel buildings at Preston Docks, Lancashire, on behalf of ANGLO-CONTINENTAL SERVICES of London and Bedford.

Intended to help accommodate this expanding "door to door" container service, operating between the United Kingdom and Northern Ireland, this impressive building which tends to dominate the dockside landscape and has a clear span of 100 ft, a length of 280 ft and eaves height of 35 ft, will be used as a dockside warehouse and transit shed for the assembling and distribution of multiple container loads.

The building, which is clad in asbestos cement sheeting is well provided with natural lighting from 6 ft deep strips of continuous glazing immediately below the eaves and also from over 225 translucent roof lights set in the roof slopes.

To interrupt as little as possible the busy day-to-day activities of Anglo-Continental Containers' Services, this S. & F. standard building was erected on the dockside in two phases. The first phase incorporated the erection of a 120 ft long building, which partly enclosed an existing free standing overhead travelling crane gantry operating between ship and depot, and the next stage was to demolish an old existing building and to expand the building erected in the first phase to its complete length of 280 ft.

During this period, Sanders and Forster also extended the existing crane gantry accommodating two 15 ton travelling cranes. Sanders and Forster state that their range of standard steel buildings is available in five distinct types, each type covering a wide range of spans and heights and catering for all industries and purposes.

They also state that the main structurals and components for their building are produced on a semi-automatic fabricating plant, which was one of the first to be installed by structural engineers in this country and which by eliminating costly man-handling and thus speeding production permits quick deliveries and low costs.

Flour Milling Contract for Brighton Firm

For a new flour mill contract valued at almost $1¼ million received from the Philippines by THOMAS ROBINSON AND SON, of Rochdale—the fourth large contract that Robinsons have received from the Philippines since the Republic established its own flour-milling industry in 1958—electric motor control gear will be manufactured in Brighton by ALLEN WEST and Company.

The largest of ten Allen West multi-motor control panels ordered for various milling operations is a 25-motor panel. It will be located on the second floor and will control agitators, offal blowers, bleachers, worm conveyors, etc.

On the mill third floor a 19-motor panel will control purifiers and plansifters, and on the fourth floor will be a 14-motor control panel for valves. In the screenroom there will be an 18-motor panel for blowers, conditioning and washing plants, screens and feeders as well as four other multi-motor panels controlling other processes. The warehouse will have a 9-motor panel for blowers and valves, and there is also to be a 4-motor panel of machine tool pattern for other duties.

The rollermill floor will have four Allen West control desks, each incorporating a process timer arranged to give a starting pulse to each of 23 motor starters at intervals of three seconds.

Rollermills will be pushbutton controlled, either individually or in groups. Seventy-two Allen West "SC2N" main direct-on starters, in single and back-to-back arrangements, will be mounted on floor stands specially designed to fit in with the motor arrangements on the mill floor.

In all, one hundred individual Allen West starters have been ordered for the new mill. It is to be built for the CENTRAL PHILIPPINE MILLING CORPORATION, and will be sited at Iligan, near Cebu City. It will have a capacity of 240 tons per 24 hours, and pneumatic conveying will be used throughout. All the machinery will be manufactured in Rochdale.

Tasker Price-Cuts in Semi-Trailers

Reductions of between £40 and £100 in the cost of their standard straight frame semi-trailers with automatic DS couplings are announced by TASKERS OF ANDOVER (1932), the Hampshire firm.

The new prices, for 8, 10 and 12 ton models, took effect from 1 August. The Showroom Sales campaign conducted by the company (see ENGNG., 17 Feb., vol. 191, p. 248) improved production methods, and the increasing demand has made the price reductions possible.

Taskers are at present engaged on the production of a wide range of trailers of all types varying in size from a 7 cwt car trailer retailing at £42 10s 0d, which is part of their standard range, to a 50 ton tank transporter for which they have just received a sizeable contract from the War Office. They export fairly extensively and of their agricultural range 50 per cent go overseas.

Ship Overhauls Keep Belfast Yards Active

The arrival this month of the SHAW SAVILL liner Southern Cross, 20,000 tons, at the Belfast shipyards of HARLAND AND WOLFF, for her annual overhaul will fill fitting out berths emptied by the departure of two new oil tankers. The Southern Cross, a Belfast built ship, sails on the United Kingdom-Australia-New Zealand service. At Belfast the Southern Cross will join another Shaw Savill ship, the Coptic, which is being repaired and overhauled in the slack spell in the New Zealand trade.

The two new oil tankers handed over to their owners last month were the George Peacock, 28,800 tons, and the 15,400 ton British Cormorant. The George Peacock is the second tanker completed in Belfast in the past year for the PACIFIC STEAM NAVIGATION Company, now building a sizeable tanker fleet. The 47,200 ton William Wheelwright, completed last year is now in service.

The British Cormorant is the most recent in a series being built for the BP TANKER Company. British yards are building three sister ships for the British Cormorant, two at Govan, on the Clyde, and the third at Belfast.

Plant Manufacturers Join Aveling-Barford

AVELING-BARFORD have bought the HOVERINGHAM ENGINEERING Company from HOVERINGHAM GRAVELS Limited. The price was around £300,000. Hoveringham Engineering, who will continue operating under their own name, produce structural steelwork, colliery surface plant, conveyor systems and mechanical handling equipment.

Following their sale of the engineering company Hoveringham Gravels will concentrate their activities on the sand and gravel interests. As part of the contract, subject to satisfactory price arrangements, the company will obtain all their gravel plants from the Aveling-Barford group for the next ten years.

The first such installation is now going in at Rainham, Essex. It is to be in production in September. When complete this will be the largest gravel plant in Britain, apart from the installation at Hoveringham.

Dowty Licence with Japanese Company

DOWTY HYDRAULIC UNITS Limited, of Ashchurch, Gloucestershire, have signed a licence agreement with the KAYABA INDUSTRY Company of Tokyo, for the manufacture in Japan of Dowty hydraulic gear pumps and motors. Manufacture will start immediately.

The countries for which exclusive selling rights have been granted are Japan, Formosa, Korea and Indonesia.

Mr. Kaisaku Asano, Managing Director of the Japanese Company last month visited Dowty Hydraulic Units Limited.

Increasing Engineering Exports to Japan

UK exports to Japan show an upward trend, and were valued at £20·8 million during the first half of 1961 as against £12·8 million during the corresponding period of last year. Exports of machinery (other than electric) increased from £2·6 million to £4·9 million during the same period, and there are good possibilities for further increased British exports of capital goods to Japan.

Due to the rapid expansion and development of Japanese industries (the ten-year plan foresees the doubling of the gross national product by 1970), Japan's imports of engineering goods are to be increased considerably, and the import policy is being liberalised. Another important aspect is that Japan has accumulated foreign exchange reserves to the equivalent of about £800 million.

Britain's competitors are very active in the Japanese market. West German exports to Japan have reached the value of DM 229 million (about £21 million) during the first four months of 1961 as against DM 162 million during the first four months of 1960. Thus the West German exports to Japan were at a monthly level of over £5 million as against the UK monthly level of less than £3·5 million, and in the case of engineering goods the discrepancy was even more unfavourable for Britain. Japan's imports of machinery and transport equipment have increased from £103 million in 1957 to £145 million in 1960, and Britain's share of these imports throughout these years accounted for only 5·5 per cent, while the imports from the United States accounted for 67 per cent, from West Germany for 12·5 per cent, and from Switzerland for 4 per cent.

As a result of a visit by a group of Japanese industrialists to several UK machine tool manufacturers during last year's European Machine Tool Exhibition at Olympia, London, British machine tool exports to Japan have increased to £861,545 during the first six months of 1961 as against £234,029 during the corresponding period of 1960, and the backlog of machine tool orders for delivery to Japan is bigger than ever in the past. There is a growing market there for various types of machine tools, including heavy types of machinery, and the British machine tool industry is to participate at the 1962 International Trade Fair in Osaka.

At present British manufacturers of capital goods are, in many cases, able to offer shorter delivery terms than their Continental competitors and British prices are competitive.

At the moment, Japan seems anxious to join in and take full advantage of the present world tendency towards freer trade and it becomes increasingly apparent that the export of UK capital goods could be augmented considerably provided this trend be exploited to the full. It is therefore imperative that every opportunity be sort to familiarise Japanese industrialists with the latest developments and achievements of British industries and British industrialists play their part by appreciating fully the potential of the Japanese market for their goods.

American Equipment to be made in Japan

HITACHI Limited, a leading Japanese industrial concern, have signed a ten-year agreement with the RADIO CORPORATION OF AMERICA, and have thus secured the technical "know how" assistance and the patent right for manufacturing of electronic data processing equipment. The agreement provides also for training Hitachi engineers at RCA factories, and for RCA engineers to train Japanese personnel in Tokyo.

RCA is to receive US $200,000 immediately, and in addition nine annual instalments (starting from the second year of the contract) of at least US $110,000 each (should 5 per cent of the total sales amount to more than US $110,000 per annum, RCA would receive a correspondingly higher remuneration).

Hitachi have already a technical tie-up agreement with IBM and are also developing and building computers of their own design (see ENGNG. 28 April, vol. 191, p. 613).

GPO Stamp Selling Machine

A vending machine which has not suffered changing currency values. Associated Automation's B4 mechanism has had 37 years of success—and it is still going strong.

For solid reliability and long life, the common-or-garden stamp selling machines used by the GPO would take a bit of beating. In what other sphere could one expect to find a precision engineered device whose design has remained virtually unchanged for so long, and for which large orders are still being placed? It is not pure conservatism—the exemplary performance of the low-cost and perhaps disappointingly simple mechanism over a period of so many years amply justifies the faith placed in it. Over 20,000 are in use in British post offices today.

Not many readers will remember Britain in the days before such machines became established. The idea of automatic vending of certain essential commodities occupied the attention of many inventors about the turn of the century, and as postage stamps had become such a fundamental requirement it is not surprising that they became the subject of some of the earliest attempts of this kind. In those days, automatic stamp-selling machines were sold on a commercial basis and were not the property of the Post Office as the majority are today. They were invariably "coin-freed" machines, in other words the insertion of the coin only freed the mechanism, which allowed an envelope of stamps to be taken out of a drawer. People would leave the drawer open and in wet weather quantities of stamps would become ruined.

Clearly, the way lay open for someone to devise a machine sufficiently foolproof and convenient to operate that it would interest the Post Office in having their own installations. A successful machine would thus be likely to create a demand for itself on a large scale.

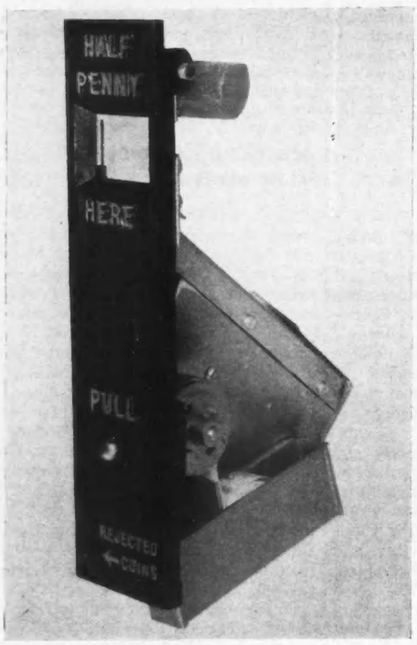


Fig. 1 Early type A machine.

Fig. 2 Refilling is a simple operation.

The machine that seemed to offer the best possibilities was one that had been invented in New Zealand by Messrs. Dickie and Brown, and was introduced into Great Britain in 1906. It at once engaged the attention of Mr. F. W. Hall who ran a small business for making inventors' prototypes, but he realized that the machine was hardly suitable for British requirements. For instance, the stamps were made in a strip instead of being perforated in the normal way, and severed by a guillotine. Stamp withdrawal was effected by raising a sliding knob.

TWO MAIN IMPROVEMENTS

Hall set out to redesign the machine, and within a year succeeded in producing one incorporating two fundamental improvements. Fitting the feed wheel with small pointed pins allowed the stamps to have the normal perforations, so that they could be detached from the strip by pulling the perforations against a toothed edge. The feeding mechanism, instead of being knob-operated, was driven by the stored energy of a pivoted weight which was first raised by the act of inserting the coin. Release was effected by an escapement actuated by the fall of the coin on its way to the cash container, which allowed the weight to descend to its original position and rotate the feed wheel by an amount sufficient to deliver one stamp through a slot.

This principle is still in use and is the common thread running through all subsequent British stamp selling machines using a single denomination of coin. More recently it has been applied to other kinds of vending machines—to sell platform tickets for example.

In 1908 a company was formed called the British Automatic Stamp and Ticket Delivery Company, with Hall a director. The Post Office ordered twelve of the improved machines for extended trials in service; one was mounted in the House of Commons and one in Threadneedle Street GPO. In 1911 100 more pairs of ½*d* and 1*d* machines were supplied. Until 1920 the company was paid in proportion to the number of stamps sold through its machines.

The first B.A.S. & T.D. Company stamp selling machines were installed inside post offices, but it was realized that such machines also had an important outdoor potential for providing a service during the hours that the post office is shut. An early try-out by the company revealed that outdoor conditions were more onerous than had been supposed chiefly due to of damp. In a modified design the stamps and feeding mechanism were in an enclosed chamber and the coin tester was slightly altered. Due to the First World War, it was not until 1921 that the Post Office ordered 240 pairs of outdoor machines.

These machines, later designated type A, were fixed outside post office buildings either in a frame on the door or in a cast iron case on the front wall. Inconvenience for loading soon led to the addition of a pivot mounting so that the stamp chamber could be turned towards the operator. In 1924 came the type B machine, in which B.A.S. & T.D. incorporated further improvements. They consisted briefly of improving the access to the stamp chamber; enlarging the chamber to carry more stamps; improving the method of securing the feed wheel cover; and modifying the EMPTY shutter mechanism to obviate premature operation caused by vibration.

It is the type B that shows such a remarkable longevity and it is a tribute to its design that modifications to it during the ensuing years have been few and insignificant. Changes that have occurred have generally been confined to the method of mounting, many variations having been introduced to suit the particular situation leaving the mechanism unaffected.

In 1928 the B.A.S. & T.D. Company was reformed to become Hall Telephone Accessories (1928) Limited, later to become Associated Automation Limited, a member of the Elliott Automation group. The version currently being supplied to the GPO is known as the B4.

The B4 mechanism is shown in Fig. 6. The machine is built up on the front plate, a hot

Fig. 3 (above) GPO internal vending suite.

Fig. 4 (below) Trial "drive-in" suite at Luton.

Fig. 5 A machine which says "I am always at your service" must not break down.

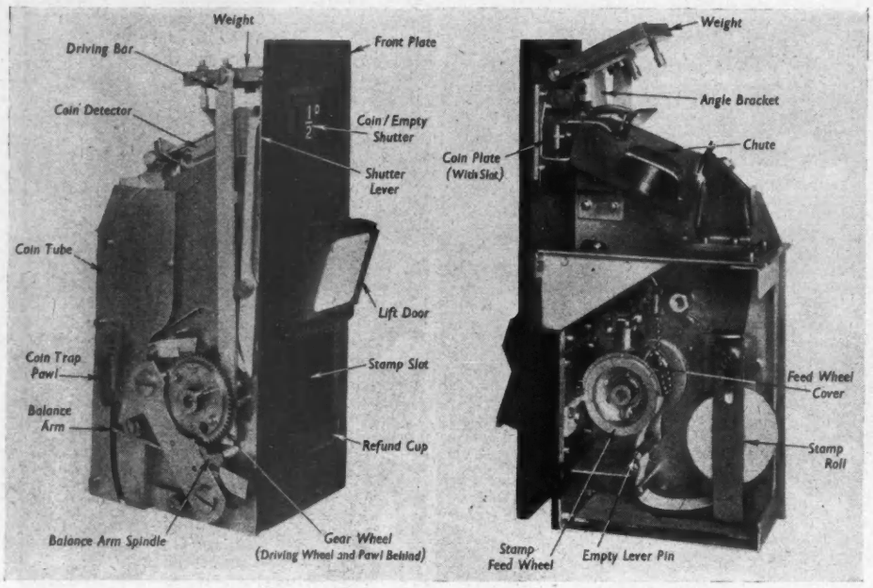


Fig. 6 B4 mechanism showing main features.

brass pressing, with an aperture at the top behind which is a coin slot. As the coin is inserted it pushes up the angle bracket and with it the pivoted weight above, together with a driving bar attached to the weight which has a rack cut at its lower end. The rack engages with the driving wheel to which is coupled the stamp feed wheel, and they can only rotate in one direction. The driving wheel pawl drives a train of escapement gears controlled by the balance arm and spindle in such a way that after the coin has raised the weight, it and the driving wheel are locked until the coin trips the balance arm.

The action of raising the weight also allows the chute to swing over into position to accept the coin, which, in order to reach the balance arm and the cash compartment beneath, must first pass along the coin detector. Failure to satisfy the detector will result in the coin falling out and down into the refund cup. A coin trap pawl prevents the machine from being fraudulently operated by a coin on the end of a string. The feed wheel cover maintains close contact between the roll of stamps and the wheel, and also provides a serrated edge against which each stamp can be torn off along its perforations.

The mechanism can also be arranged to give two stamps for one coin by doubling the angle of rotation of the feed wheel for each coin inserted. Alternatively it can be arranged to deliver one stamp for two coins by modifying the driving wheel escapement. When the roll of stamps becomes exhausted or in the unlikely event of the roll breaking, the empty lever pin is no longer supported by the stamp strip and swings down. This action operates a lever which releases the empty coin shutter, allowing it to slide down and reveal the wording EMPTY or NOT IN USE and cover the coin entry slot.

Another contributory factor to the success of the B4 machine is the negligible maintenance requirement. The most important routine job is to ensure that the silica gel drying unit fixed inside the cover of the stamp compartment remains active. In very damp situations it may be necessary to change the contents each time the machine is refilled with stamps. Otherwise the occasional drop of watch oil on the bearings and periodical cleaning of the coin detector and chute will give it an almost infinite life.

It is now time to consider the GPO's policy under which the B4 mechanism has flourished for so long, generally in the guise of the 1*d* and ½*d* machine mounted together in pairs. Their most rapid rise in popularity took place during the period 1922-39 when the standard letter rate was 1½*d*. When postage rates started altering, the GPO saw no reason to start modifying the mechanism, since any postage value can be made up by using a suitable combination of 1*d* and ½*d* stamps.

The B4 mechanism did, however, appear in limited numbers in two other forms. For certain sites away from post offices where business was low a machine was introduced in 1925 selling two ½*d* stamps for one penny. Generally they were mounted in a CI case attached to a pillar box, and there are some 2,600 in use today. There were also about 400 machines introduced more recently giving a 2*d* stamp for two pennies. They are mostly at seaside resorts, and their usefulness diminished when the postcard rate rose to 2½*d*.

In 1953, to reduce inconvenience, the B4 mechanism appeared in yet another form, this time a 3*d* stamp machine. It was made possible by an important technical step forward, the design of a satisfactory coin tester and chute for dealing with 3*d* pieces. At first, 100 existing B4 machines were modified for service trials to test the public reaction, and they proved so successful that the Postmaster General has now announced his intention of providing one outside every Crown post office. Orders have been placed for 2,400 of them, and they are being installed alongside their faithful 1*d* and ½*d* forbears.

To still further improve the service to the public and yet not to be too heavily tied down by the postage rates in force there is a tendency today towards machines selling booklets of stamps, letter cards and stamped envelopes. A combination of such machines mounted in a suite inside post offices, together with those for selling stamps (and at some offices, postal orders), should go a long way towards reducing those irritating queues at the counters, in addition to the 24-hour service provided by the machines outside. Indoor suites are gradually being introduced on trial as shown in Fig. 3.

Fig. 7 The 1/- booklet machine, now changed to 2/-.

BOOKLET MACHINE

The stamp booklet selling machine differs from the stamp selling machine with B4 mechanism firstly in that it is coin freed; and secondly because it is the product of a different manufacturer.

This machine started in 1937 when the GPO invited three manufacturers of razor blade machines to supply six machines each, modified to suit a 6*d* booklet, for service trials to explore the public demand. The demand was clearly established and the makers of the most reliable machine, Messrs. Brecknell, Dolman and Rogers Limited of Bristol, were then asked to develop a prototype to fit in standard GPO mountings, and to incorporate the roller delivery which they provided on London Transport ticket machines.

The war caused postponement and it was not until 1948 that the 6*d* prototype was modified to suit a 1*s* booklet and put into production. More recently it has been modified to give a 2*s* booklet for a florin, and it too is to be mounted outside each Crown post office. So the success of the original B4 mechanism has encouraged the GPO to extend the vending principle, to the benefit of more than one manufacturer.

Present day policy is for the GPO to place research and development contracts, by competitive tendering wherever possible, for the design and prototype of every type of machine and to control patent and design rights in the UK. Contracts for bulk manufacture are, of course, the subject of competitive tendering.

The letter card and stamped envelope machines are coin freed and are made by Associated Automation, as also are the postal order machines for post office suites. The introduction of the 3*d* piece coin tester has resulted in two-denomination letter card and stamped envelope machines using one 3*d* piece and one penny.

The British GPO have given serious consideration to the idea of introducing change giving as a selling machine function, but have finally rejected it in favour of using a separate change giving machine in the most needful situations, i.e. in the suites where machines requiring a 3*d* piece are present. Portable suites for use at conferences and exhibitions are also in service. The GPO's policy of first testing public reaction to every innovation to ensure that they are providing the best possible service cannot be praised too highly.

When you first use the new suites, spare a thought for the little B4 mechanism from which it all began—more than one of which exist inside.

Computer Based on Molecular Circuitry

A "molecular-electronic" computer, one-tenth the size and weight of a transistorized computer with the same capabilities, is now under development at the Westinghouse Electric Corporation's air arm division at Baltimore, USA.

The concept of molecular electronics (ENGNG., 4 March '60, pp. 338, 339) offers many exciting possiblities in the field of equipment miniaturisation. Unlike other forms of circuit-size reduction, which achieve results through the use of smaller circuit elements (transistors, resistors, etc.), the molecular system makes no use of macroscopic components at all.

By creating "active domains"—which can be given reactive, resistive or amplifying properties —within the molecular structure of a single crystal, a complete electronic circuit is built up. Demonstrations of such circuits have shown that the electronic interactions between molecular domains produce the same overall effect as that obtained from a conventional circuit using macroscopic components.

The new Westinghouse Electric device has been given the name "Mol-e-com," which is short for molecular computer. It will have significant applications in space engineering, where its minute size and weight and its intrinsic reliability will be of obvious importance. The entire computer will weigh less than 15 lb and occupy less than one third of a cubic foot, instead of the 175 lb and three cubic feet required by a conventional transistorized computer of similar working capacity.

However, valuable as the 10 to 1 size and weight reductions are, an even more important factor in favour of the molecular computer is its reliability. This feature is inherent in the molecular technique due to the fact that very few wire connections are required. In a normal circuit, where each component must have at least two connections attached, the overall reliability is reduced quite considerably due to the fact that electrical joints have an appreciable failure rate.

In one instance, an entire molecular electronic system, including a computer, was designed to work with 26 molecular blocks. Its optimum counterpart in conventional circuitry would have used at least 118 parts. Further design and development studies, which are now in hand, may eventually reduce the number of blocks for this particular system from 26 to three.

Westinghouse research staff have been working on the problems of microminiaturization, particularly for military applications, for the past three years. Work on the molecular electronic technique began two years ago.

Cements to Resist Chemical Attack

Deterioration of concrete when used for foundations in contaminated soil, as constructional material for tanks and floors in chemical industry, for flues and chimneys, and in sewage works carrying corrosive effluents, has led to the development of cements more resistant to corrosion by chemical attack than is ordinary Portland cement.

Working mostly on behalf of concrete-producer firms, the DSIR's Building Research Station has carried out some investigational work on this form of chemical attack.

A five year programme, designed to study the effects of various sulphate solutions on fresh concrete made with six differing cements has now been completed. The cements used were three ordinary Portland types having tricalcium aluminate (C_3A) contents of nine, ten and eleven per cent respectively, low heat Portland cement, sulphate resisting cement, and high alumina cement.

The attacking solutions employed to investigate corrosive-resistance properties were: (1) strong magnesium sulphate (3·5 per cent SO_3); (2) strong sodium sulphate (3·5 per cent SO_3); (3) weak magnesium sulphate (0·35 per cent SO_3); (4) weak sodium sulphate (0·35 per cent SO_3); and (5) saturated calcium sulphate (0·12 per cent SO_3).

The effects of the sulphate solutions on the various cements after five years exposure were published in the Station's Annual Report for 1960, and are as follows:

High alumina cement	Unaffected by any of the solutions in five years.
Low heat cement Sulphate resisting cement Ordinary Portland cement (9 per cent C_3A)	Indications of attack by strong magnesium sulphate solution only, after five years.
Ordinary Portland cement (10 per cent C_3A)	Indication of attack by all solutions in five years.
Ordinary Portland cement (11 per cent C_3A).	Serious attack by all solutions in two years.

It was clear from this study that even good quality concrete made with ordinary Portland cement of high tricalcium aluminate content will be seriously attacked by calcium sulphate in a relatively short time. The illustration shows the advanced state of decay of the four cylinders made with the high tricalcium aluminate cement when exposed to saturated calcium sulphate solution. This is a point of some importance because it is often suggested that calcium sulphate is too insoluble to have any serious effect.

In further tests designed to compare various types of cements, supersulphate cement of British manufacture behaved in the same manner as that of Continental origin, resisting sulphate solutions well with the exception of strong solutions of magnesium sulphate.

Concrete test cylinders after five years in a saturated solution of calcium sulphate. Four cylinders with Portland cement have been seriously attacked.

Studies of Electrostatic Mineral Separation

Separation of minerals by electrostatic precipitation is known to work well, but less is known of the fundamental principles involved. Using industry's most favoured machine, the roll-type corona-wire separator, research engineers at the Warren Spring Laboratory have been investigating the relationships between the behaviour of mineral particles in the machine and the relevant physical properties of surface conductivity.

As a preliminary to the study of the effects of heat and chemical conditioning on the behaviour of minerals during separation, the effect of relative humidity on closely-sized fractions of quartz, beryl and mozanite was investigated under various operating conditions. Curves have been drawn enabling optimum conditions for separation to be predicted. In accordance with theory, the percentage of mineral reporting as conductor increased steadily with humidity, but there was an unexpected increase in the percentage of mineral reporting as a conductor at about 60 per cent relative humidity.

The relevant physical factor in this roll-type method of high tension separation is the surface conductivity of the mineral particles, and instruments and techniques are being developed to carry out the necessary measurements on bulk granular material. Preliminary measurements have been made on materials conditioned at relative humidities from 20 to 100 per cent. The instruments have been designed and built to operate at the normal plant operating voltage of about 30 kV. Because the technique of measuring resistances of up to 10^{16} ohms at high voltages has not yet been perfected at the Laboratory, initial work has been carried out at about 1 kV. In addition to these measurements on bulk granular material, new instruments have been developed to study the behaviour of individual mineral grains under conditions similar to those that are normally occurring in the high tension separator.

Although from a practical viewpoint it is less satisfactory to measure the surface conductivity of individual grains than of bulk mineral grains which will actually be passed through the separator, this measurement is only an empirical one.

Accordingly, a technique has been devised to measure the surface conductivity of polished mineral prisms (preferably single crystals); like the method for bulk granular material, this has sufficient sensitivity to measure resistances up to about 10^{17} ohms using an applied voltage of at least 1 kV. Preliminary measurements have been made on mineral prisms at relative humidities ranging from 20 per cent to 100 per cent.

So far, these measurements accord with the behaviour of the particulate matter under full-scale conditions.

Brittle Fracture in Welded Structures

By B. Cotterell, B.Sc.(Eng.), Ph.D.

The "wide plate test" as developed by the BWRA simulates brittle behaviour in welded constructions. A brief description is given of the more important features of fracture and its prevention in 1 in and 3 in thick plate.

THE catalogue of catastrophic failures shows very clearly that consideration of the possibility of brittle fracture in large welded structures is imperative. The Liberty ships of the Second World War provide a classic example. However, not only ships but nuclear reactor pressure vessels, storage and other vessels create brittle fracture problems.

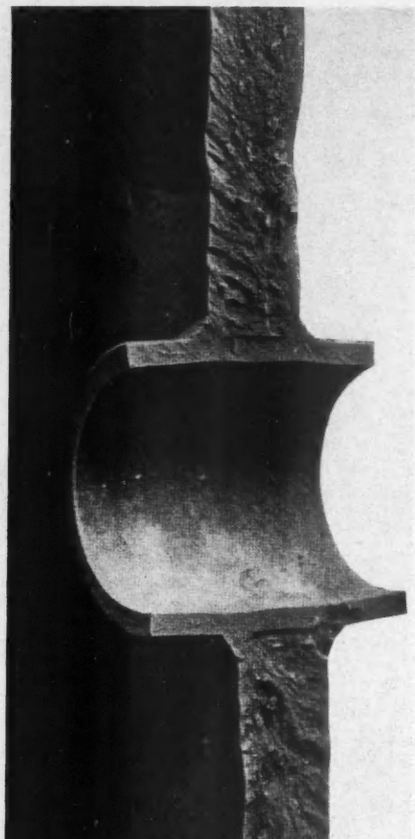
Most service failures have occurred at stresses below the yield. However, steel plate when sharply notched and tested in tension, at a temperature not more than about 100° C below the fracture appearance transition, will fail in a brittle manner only after the whole plate has yielded. Only in massive specimens of alloy steel have such failures occurred before yield. In service the origin of most brittle fractures has been in butt welds of poor quality at a slag inclusion or post welding crack. The initiation of fractures in service at lower loads is, therefore, assigned to the effect of a natural notch in the presence of a weld.

When a weld cools, concentrated plastic flow occurs at the root of any notch, locally embrittling the plate. Due to the restraint of natural shrinkage along the weld by the rigidity of the unheated plate, residual stresses are induced which are equal to yield.

Wide Plate Test

The wide plate test was designed to simulate the casualty behaviour in the laboratory. The normal specimen consists of two 36 in by 18 in plates butt welded together. It is necessary to use plates as wide as this if there is to be full restraint on the weld. Since natural flaws are not easily produced under controlled conditions an artificial flaw is introduced by cutting fine coplanar saw cuts into the weld preparation. These saw cuts are not buried by the welding.

Brittle fracture is not a problem in thin plate. Here the plastic zone at the root of a notch is comparable to the thickness and there is little restraint on plastic flow. Thus unless the temperature is very low the plate will not behave in a brittle manner. The restraint on plastic flow increases with thickness and brittle fracture becomes more probable. Thus it is necessary to test plates from ½ in upwards. With a 36 in wide specimen this implies a large capacity machine. Two such machines have been designed and constructed at the BWRA with capacities of 700 and 2,000 tons. These are capable of testing mild steel in thicknesses up to 1 in and 3 in respectively.



Brittle fracture of "as welded" wide plate, simulating a pressure vessel nozzle.

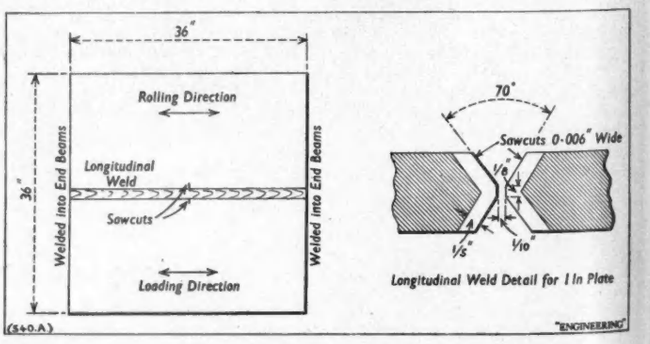
The mode of operation of the machines can best be seen in the 700 ton rig. The 36 by 36 in test plate is welded into the end beams. These are loaded, through rams, by four hydraulic capsules with working pressures up to 5,000 lb per sq. in. Since brittle fracture usually implies small strains these capsules have a limited travel. The only moving part is a flexible aluminium alloy ring which bridges the two heads of the capsule. If larger strains are required packing can be introduced between the rams and the end beams. To obtain low temperatures the plate is cooled with "dry ice" contained in four boxes clamped to the surfaces. Two tubes, fitted to the ends of the tie bars, absorb the large energy release at fracture by crushing. The load and deflection of the plate is recorded autographically from a pressure cell and strain gauged deflection ring. The 2,000 ton rig is similar in operation, but has 12 capsules instead of four.

Brittle Behaviour of 1 in Thick Mild Steel

The 700 ton rig has been used to test six mild steels: three semi killed and three fully killed and normalized. The behaviour of all the steels is best illustrated by the results for one of the semi killed steels (0·14 per cent C, 1·07 per cent Mn). Above −5° C the strength of this plate is above yield. The fractures are rough, but crystalline, with the typical chevron markings. There are small shear lips along the plate edges. At and below −5° C only two out of the 12 plates reach yield strength. The others exhibit smooth low stress fractures. Four of these were arrested due to there being insufficient energy for propagation outside the residual stress zone. To reinitiate these fractures the remaining section must be yielded.

In general the correlation between the transition temperature as measured by any of the standard small scale tests, and that at which low stress initiation first appears in the wide plate, is poor. However, a better correlation is obtained from Charpy V notch impact tests on "strain aged" plate. This condition corresponds closely to the material near the notch of the wide plate test which has been plastically strained and subsequently aged during the welding operation. There were no low stress fractures at temperatures where the energy absorption, in Charpy tests on "strain aged" plate, was greater than 10 ft-lb. However, it must be realised that the curve of energy absorption for this condition is very flat and this reationship cannot receive unqualified practical recognition.

The notch ductility of the weld metal does not have a large effect on the behaviour of the wide plate test. It is the soundness of the weld that is important. In these tests the weld metal had a transition temperature near − 15° C. Both rutile and low hydrogen basic covered electrodes were used, the former almost invariaby leading to some cracking during the welding operation. Those plates which had post welding cracks can be easily distinguished on the plot of fracture strengths. The lack of sensitivity to notch ductility of the weld metal has also been confirmed by tests on a nickel alloy steel using both a selected electrode with a very low transition temperature and a low hydrogen basic covered electrode as in the above tests.



Specimen details of wide plate tests for brittle fracture research.

Research Report

on work of the

British Welding Research Association, Abington Hall, Cambridge

Director of Research

R. WECK, Ph.D., M.I.C.E., M.I.Mech.E.

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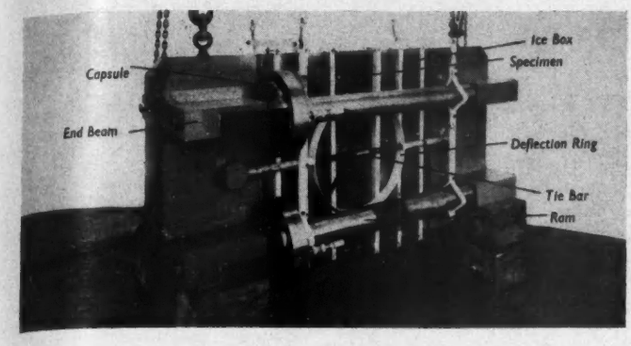
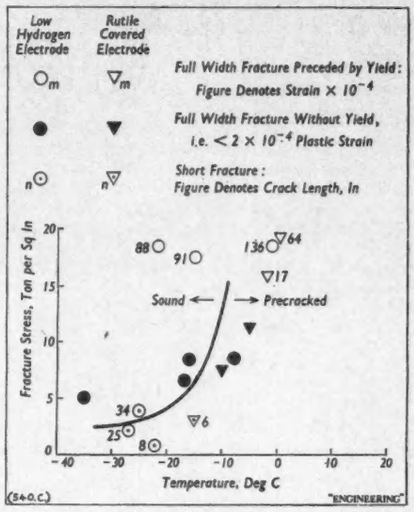


(*Left*) *700 ton wide plate test rig.*

(*Right*) *Fracture strengths of a 1 in mild steel plate (0·14 per cent C, 1·07 per cent Mn).*


Low Hydrogen Electrode
Rutile Covered Electrode
Full Width Fracture Preceded by Yield: Figure Denotes Strain × 10⁻⁴
Full Width Fracture Without Yield, i.e. < 2 × 10⁻⁴ Plastic Strain
Short Fracture: Figure Denotes Crack Length, In
Fracture Stress, Ton per Sq In
Sound
Precracked
Temperature, Deg C
(540C.)
"ENGINEERING"

Effect of Stress Relief on 1 in Plate

Residual stress plays a major role in producing low stress fractures. When a central strip, 4 in wide, is cut from a wide plate specimen, most of the residual stresses are released. The fracture strengths of these specimens were all above yield. Mechanical stress relief of wide plates, i.e. stressing above the transition temperature, also removes the high residual stress. However, the material at the root of the notch is embrittled still further by the additional plastic flow. Plates so treated are safe for loads below the preload, but will not withstand an appreciable degree of plastic strain.

Stress relief by heating the plate isothermally removes a large proportion of the residual stresses. Some improvement is also made in the notch ductility of the "strain aged" material at the root of the notch as can be demonstrated by testing stress relieved, "strain aged" Charpy specimens. With a stress relief at 650° C for 1 hour low stress fracture in the wide plate test is prevented, even at the lowest testing temperature (− 70° C with semi-killed steel already discussed). The transition from high to low stress failure has not yet been determined as it has not been possible to reach low enough temperatures. Liquid nitrogen cooling is now being developed. Thus it may be inferred that isothermally stress relieved welded constructions in up to 1 in thick plate should possess satisfactory strengths and ductilities, even in the presence of minor weld defects, at temperatures a good deal below the normal transition. However, large plastic deformation would be dangerous. Also it is difficult to predict the precise minimum operating temperature for actual constructions from a small test.

About 90 per cent of the residual stresses are relieved with a 650° C heat treatment. Wide plate tests have been made with stress relieving temperatures of 450° and 500° C for which the estimated relief is 30 per cent and 50 per cent respectively. The prefracture extension with a 500° C stress relief is not significantly less than with a 650° C treatment. However, there was no prefracture extension when a 450° C treatment was used. These results give a tentative idea of the degree of stress relief that is necessary.

In large constructions such as storage vessels and pipelines it becomes necessary to examine the possibility of a local heat treatment. Due to thermal strain incompatibility, additional stresses are induced on cooling, but provided the temperature gradients are small these can be kept to acceptable limits. However, it must be realized that in many cases the largest residual stress can only be decreased at the expense of an increase elsewhere. For example, if a strip is heated along a butt weld, provided it is wide enough, the longitudinal residual stresses will be reduced, but the transverse will increase. No tests as yet, have been made on locally stress relieved plates.

Brittle Behaviour of 3 in Thick Mild Steel

Thick plate is now widely used for many applications such as nuclear reactor pressure vessels. Its brittle behaviour cannot be inferred directly from that of thinner plate. Steelmakers have made great efforts to produce thick plate without loss of notch ductility as measured by a small scale test. However, the thick plate imposes an essentially more severe mechanical stress condition. Plastic flow at the root of notches is more restricted and higher local stresses are produced, for the same overall strain, than in thinner plate.

Supplies of 1 in and 3 in thick plate (to a gas cooled nuclear reactor vessel specification JTA101) rolled from the same cast and normalized to produce similar Charpy properties were obtained so that the geometrical size effect could be isolated. In the first 3 in test series the artificial notch was cut into the apex of the double V weld preparation and only occupied the mid-thickness. The notch area was the same as in the 1 in plate. These tests showed no distinct transition in behaviour. It was noticed that in all the low stress failures, the fracture was divided and met, with a slight step, at the mid-thickness of the plate. Chevron markings showed that the fractures had initiated towards the surfaces of the plate. This led to the suspicion that the multi-run welding technique had caused the longitudinal residual stresses to be relieved near the plate mid-thickness. Measurement of these stresses through the thickness confirmed that they are concentrated towards the plate surfaces. The next tests were made on plates with notches, of the same total area, which were cut into the preparation near the plate surfaces.

These plates showed a large, consistent drop of strength from yield point above −8° C to uniformly low values below this temperature. Comparing these results with those obtained from 1 in plate it is seen that the transition from high to low stress is not appreciably altered. However, the prefracture extension in those plates which yielded was much smaller in the 3 in plates.

The work so far described has been concerned with notches in the form of weld defects. To investigate the effect of a design notch, tests were made which simulated a partial penetration pressure vessel nozzle. A pipe, to simulate a nozzle, 8⅝ in diameter, ⅝ in wall was welded into the centre of a 3 in thick plate. There were no artificial notches. One specimen was tested in the "as welded" condition at −10° C. This failed on the plane of the minimum cross section, but only after extending by more than 0·5 in. A stress relieved specimen was also tested and was extended by 1 in without failure.

Stress Relief of 3 in Plate

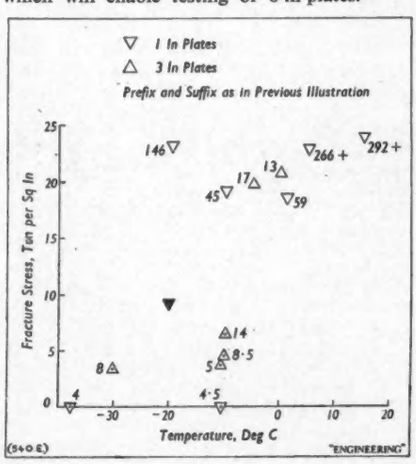
Tests have been made on 3 in thick plates isothermally stress relieved at 650° C for 3 hours. Because plastic restraint is greatest at the plate midthickness a central notch was used in these tests. As with the 1 in tests there were no loss stress failures, but there was a definite transition in the prefracture extensions. At and above 0° C the plastic strain was greater than 2·5 per cent, whereas at and below −15° C the largest plastic strain was 0·31 per cent. Only one stress relieved 1 in plate was tested and at −30° C this had a prefracture extension of 1·78 per cent. These small ductilities in stress relieved thick plate may have to be accepted as inevitable since the strains necessary to reinitiate an arrested fracture are also rather low in this temperature range.

Future Work

In nuclear construction today, the trend is to steels even thicker than 3 in. The increased resistance to plastic flow will make initiation still easier and the prefracture extensions smaller. This may raise the transition temperature. For this reason a 4,000 ton rig is under construction which will enable testing of 6 in plates.

(*Left*) *Typical fracture surfaces in 1 in plate. (A) Through fracture at stress above yield; (B) An arrested low stress fracture. (C) Through fracture at low stress.*

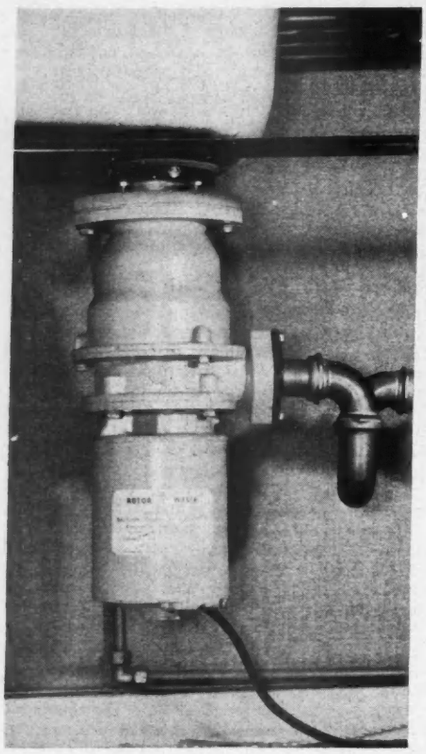
(*Right*) *Comparison of fracture strengths of 1 in and 3 in thick plate.*



Waste Disposal

PROBLEMS concerning the disposal of kitchen waste have become no less acute with recent developments, and every new block of flats adds to the difficulties. So does the installation of modern (and efficient) central-heating boilers, which will not burn rubbish—whether they be gas, oil, or solid-fuel fired. As a result, the disposal unit to affix to the sink has been produced which will grind and shred bones or waste matter small enough to be washed away down the drain. Of two recent models the first is a fixed unit for installation under the sink in the waste pipe, but the second is a new departure, in that it is portable and free standing, being intended to stand on the draining board.

The first unit is made by British Doby Stokers Limited, and marketed by Federated Foundries Limited, 4 Stratford Place, London W1. This unit is called the FF Rotor Waste and is designed to fit to any sink having a 3½ in diameter waste hole with a ½ in rebate. The outlet is on one side and feeds directly to a standard trap. To facilitate fixing the outlet is provided with an FF patent joint to suit a 1½ in copper waste pipe, but jointing rings suitable for other materials can be supplied.

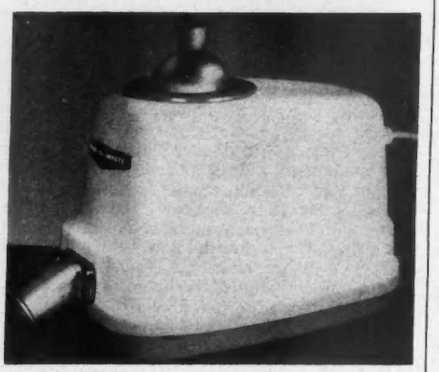


Power to drive the rotating cutter is provided by a ½ hp high-torque motor, running at 1,400 rpm and wound for 230-250 V single phase 50 cycle supplies. A thermal cutout with a manual reset button is incorporated to protect the motor from damage if over-loaded by unsuitable material being fed into the machine. All rotating parts are balanced to prevent vibration and the unit incorporates a cutter ring of patented design and cast from a long-wearing alloy. As an optional extra a reversing switch can be fitted which reverses the direction of rotation to clear small jams and to ensure even wear on both surfaces of the cutter ring. The switch is arranged so that when turned in one direction it gives successively stop-forward-stop-reverse operation to even out the running times.

The FF Rotor Waste stands 17½ in high and weighs approximately 35 lb. From the bottom of the sink to the waste outlet is 9 in. All normal kitchen waste small enough to enter the 3½ in opening can be handled and the rubber materials employed are safe up to 170° F. In spite of this, cold water should normally be used particularly if fatty waste is being disposed of.

Shown in the second illustration, the Clear-a-Waste portable disposal unit works on the same principle. It is made by Delapena Mechanical Developments Limited, 6 Russell Gardens, London W14. Measuring 8½ in high by 12 in long by 9 in deep, it is designed to stand on the draining board, on a shelf or actually in the sink. Flushing water is supplied through a flexible hose attached to a swivel cap over the waste inlet. The outlet is at one end as shown. To introduce the matter to be pulverized, the cap is freed and swung sideways to leave the opening clear.

The cutter is driven by a ½ hp motor taking its supply from standard mains through a flexible cable. It is claimed that all kitchen waste can be pulverized, including bones and broken glass. As the weight is only 20 lb it is not too heavy to be moved easily and it stands on four rubber feet.



(Above) A portable unit for pulverising kitchen waste, the Clear-a-Waste, can stand on the draining board.

(Left) Fitting under the sink, the FF Rotor Waste is reversible to give even cutter wear.

The hose is designed to fit any standard tap including Supataps and most sizes of mixer taps. Glass fibre is used for the outer case which gives a smooth easily cleaned exterior and also reduces noise.

If desired, the unit can be converted to a permanent fitting and a kit is available for the purpose. The inlet is designed to fit a standard 3½ in sink and the outlet nozzle is simply replaced by a connector to fit the normal waste pipe. The great advantage of this arrangement is that the unit can be purchased at any time and used with sinks that have non-standard outlets, without any special fittings or adaptors. Later, if the sink is changed, it can be made into a permanent fitting.

Although these two units and others like them already on the market are capable of dealing with normal kitchen waste, there is another type of waste that they are not designed to handle and which is fast becoming a trouble, particularly in the all-electric house. This is paper, and there is a steady increase of it. Apparently, some local councils are objecting to the amount of paper being put in dustbins—but what else can be done with it in a house that has no fireplaces and uses oil, gas, or electricity for central heating? Electric incinerators of a size, and at a price, suitable for the ordinary householder apparently do not exist. If local councils are seriously going to object to having paper in dustbins (and with nearly everything coming wrapped or in cartons the quantity must be pretty large) some alternative means of disposal will be essential, because the all-electric house (and particularly the all-electric flat) is steadily becoming more common.

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Published every Friday by Engineering Ltd. at 36 Bedford Street, London WC2, England.
Telephone: Temple Bar 3663.
Telegrams: Engineering Lesquare London.

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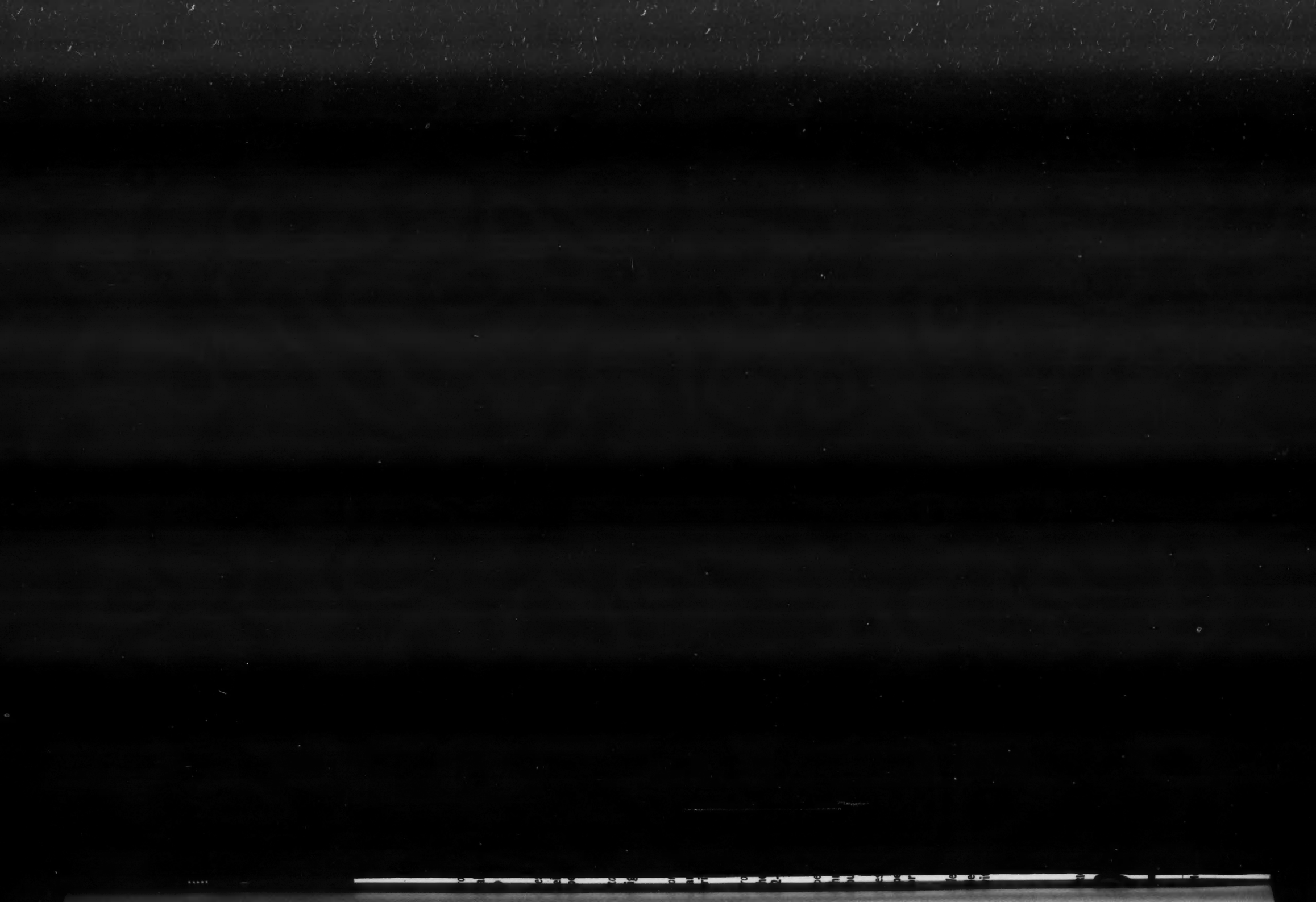
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